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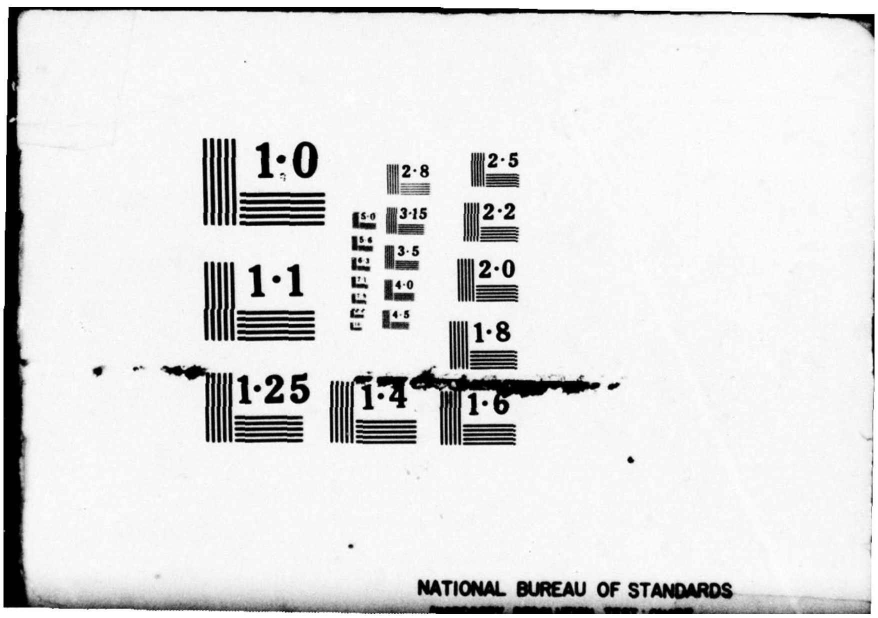
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March 1978

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Strategic Nuclear Forces	Gross Yield
Strategic Nuclear Delivery Vehicles	Equivalent Megatons
Independently Targetable Warheads	EMT
ICBM Throw-Weight	Ballistic Missile Delivery Accuracy
SLBM Maximum Range	Hard Target Kill Capability

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of this report is to compile and describe the measures of effectiveness which have been used in the comparisons and analyses of US and Soviet strategic nuclear forces and weapon systems. Historical trend plots of twelve general measures of effectiveness and, where applicable, relevant subsets of these measures are presented. For each of the measures, a description is also provided which identifies the limitations and uncertainties associated with the particular measure.

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19. KEY WORDS (Continued)

Counter Military Potential
CMP
Retaliatory Equivalent Weapons
Strategic Defensive Systems

20. ABSTRACT (Continued)

The twelve basic measures considered are:

- Strategic Nuclear Delivery Vehicles
- Independently Targetable Warheads
- ICBM Throw-Weight
- SLBM Maximum Range
- Gross Yield
- Equivalent Megatons (EMT)
- Ballistic Missile Delivery Accuracy
- Hard Target Kill Capability
- Counter Military Potential (CMP)
- Surviving ICBM Launchers After a First Strike
- Retaliatory Equivalent Weapons
- Strategic Defensive Systems

In the preparation and presentation of these data a conscious effort has been made to provide an unbiased trend analysis of each measure based on valid source materials and comparable data. The primary sources of system characteristics and annual inventory strengths were: Projected Strategic Offensive Weapons Inventories of the US and the USSR an Unclassified Estimate, US Library of Congress Congressional Research Service, and The Military Balance 1977-1978, The International Institute for Strategic Studies. For a complete listing of sources see the Bibliography (Appendix B).

The purpose of this report is not to make conclusions on the relative strategic balance, but to provide a compilation of strategic measures of effectiveness which can be used as inputs into an analysis of the strategic balance. Although a knowledgeable strategic analyst may consider some of the discussions elementary, the report has been so structured to provide the necessary information to a wide range of readers.

SUMMARY

For the general period covered by this report (1960-1982), most of the measures show a shift from a clear US advantage to a Soviet advantage. Table 1 illustrates when such shifts occurred in some of the measures and the anticipated advantage ratios in 1982.

The only measures contained in this report in which the United States will apparently maintain a clear advantage is in (1) numbers of intercontinental bombers and (2) independently targetable Submarine Launched Ballistic Missile (SLBM) warheads.

It should be noted that with the exception of two measures * bombers are not included. The two primary reasons for excluding bombers from the other measures are the wide variations in possible bomber loadings and the classified nature of these data. Since the US strategic bombers have and are projected to have a significantly greater payload and weapon carrying capability than Soviet aircraft, it can be assumed that the United States will continue to maintain an advantage in bomber delivery capability. However, if the Soviet BACKFIRE bomber (which has an intercontinental capability) were to be included, the apparent US advantage in bombers could be eroded.

In the case of independently targetable SLBM warheads, the US advantage depends upon the result of Soviet efforts to develop, produce, and deploy Multiple Independently targeted Reentry Vehicle (MIRV) warheads for Soviet SLBMs. The Soviet Navy already has a growing advantage in both numbers of nuclear-powered ballistic missile submarines (SSBNs) and SLBMs.

Of the selected measures shown in the following summary table, the Soviet Union had achieved equality by the late 1960s in numbers of Intercontinental Ballistic Missile (ICBM) launchers, independently targetable ICBM warheads, total ICBM/SLBM gross yield and Equivalent Megatons (EMT), and ICBM throw-weight. The trend of a shifting balance continued during the early and mid-1970s and the Soviet Union has now achieved equality or an advantage in five additional measures: SLBM launchers, total strategic nuclear delivery vehicles, ICBM hard target kill capability, Counter Military Potential (CMP), and retaliatory equivalent weapons.

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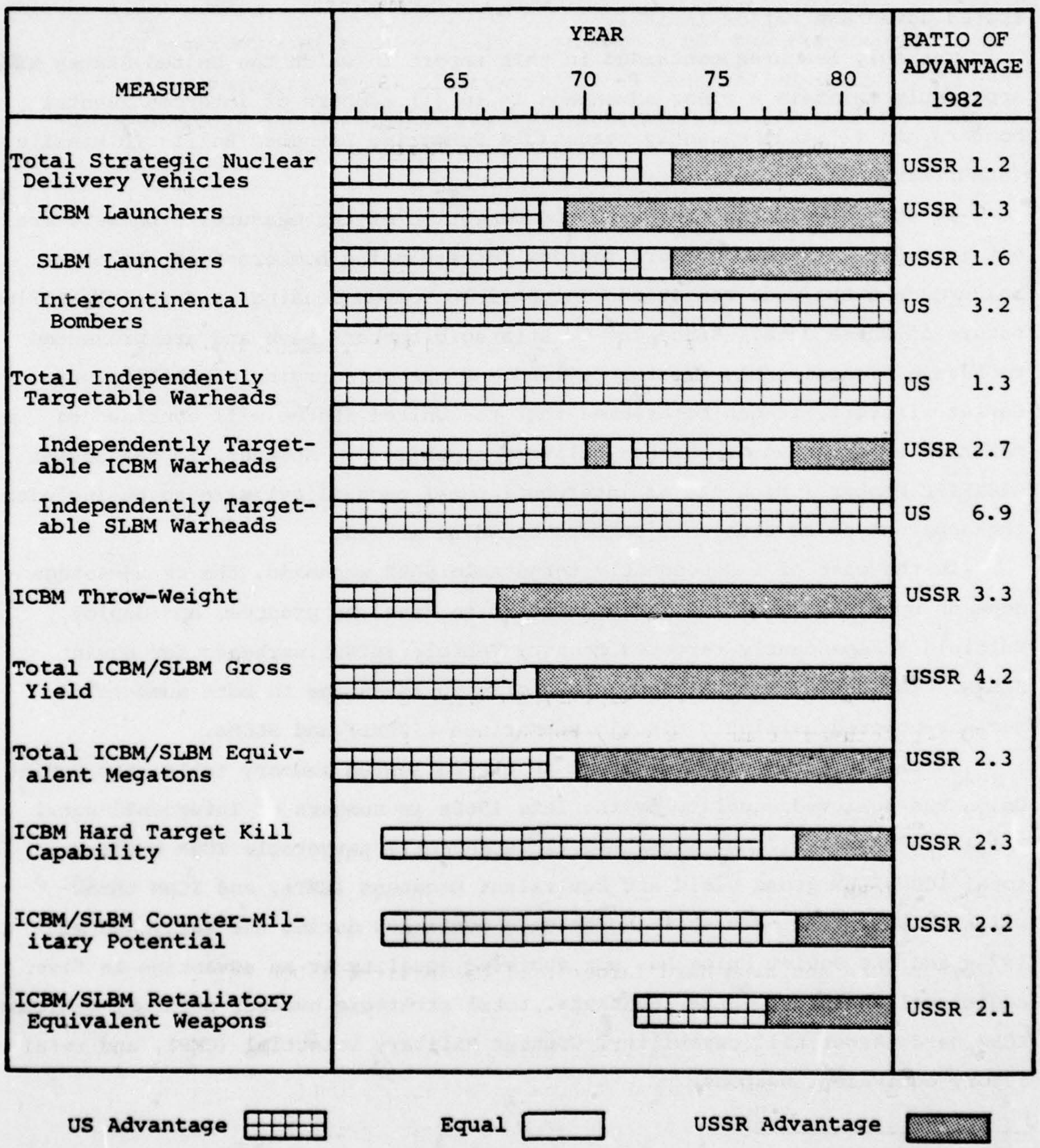
* Intercontinental Bombers and Total Strategic Nuclear Delivery Vehicles

TABLE 1

TRENDS IN US AND USSR STRATEGIC FORCES



LIST OF MEASURES

LIST OF MEASURES (Cont)

SECTION	CONTENTS	PAGE

GLOSSARY OF TERMS

ABM	Anti-Ballistic Missile
ASW	Anti-Submarine Warfare
BMD	Ballistic Missile Defense
Bus	See PBV
CEP	Circular Error Probable (indicator of weapon accuracy; it is the radius of a circle within which half of the warheads are expected to fall)
EW/GCI	Early Warning/Ground Control Intercept
ICBM	Intercontinental Ballistic Missile (approximately 3,000- to 8,000-nautical mile range)
IRBM	Intermediate-Range Ballistic Missile (approximately 1,500- to 3,000-nautical mile range)
KT	Kiloton (equivalent to 1,000 tons of TNT)
LRA	Long-Range Aviation (Soviet Avitsiyz Dalnovo Deistviya)
MIRV	Multiple Independently-targeted Reentry Vehicle
MRBM	Medium-Range Ballistic Missile (approximately 600- to 1,500-nautical mile range)
MRV	Multiple Reentry Vehicle
MT	Megaton (equivalent of 1,000,000 tons of TNT)
PBV	Post-Boost Vehicle (vehicle that carries multiple reentry vehicles; generally known as "bus")
PVO	Air Defense Forces (Soviet Protivo-Vozdushnoi Oborony Strany)
RV	Reentry Vehicle
SAC	Strategic Air Command (US)
SALT	Strategic Arms Limitation Talks
SAM	Surface-to-Air Missile
SLBM	Submarine-Launched Ballistic Missile
SRAM	Short-Range Attack Missile
SRF	Strategic Rocket Forces (Soviet Raketnyye Voyska Strategicheskogo Naznacheniya)
SSB	Ballistic Missile Submarine (diesel-electric)
SSBN	Ballistic Missile Submarine (nuclear)
TAC	Tactical Air Command (US)
VN	Vulnerability Number

SECTION 1: GENERAL BACKGROUND

From July 1945 until August of 1949, when the Soviet Union exploded its first nuclear device, measures of strategic nuclear balance were not necessary as the United States had a nuclear monopoly. Since then, analysts have confronted the problem of portraying the strategic nuclear balance in a meaningful manner.

In 1949, the only available nuclear delivery vehicle was the manned bomber. Because of the weight of early nuclear weapons (over five tons), bombers of the late 1940s and early 1950s could only carry a single weapon. In 1949 the US nuclear-capable aircraft force consisted of piston-powered B-29s, B-50s, and B-36s. Of these, only the B-36 had the capability to fly a 10,000 mile (intercontinental) mission carrying a single nuclear weapon. At the time, the only Soviet nuclear-capable platform was the TU-4 BULL, which was a direct copy of the US B-29.

The basic unit of nuclear force to the analyst in 1949-50, was the delivery vehicle. However, inasmuch as there were more bombers than weapons available, the analyst's first complication arose.* Other considerations that had to be taken into account were: the number of bombers operational, bomber range, and, as time passed and new bombers and lighter weapons were introduced into the strategic arsenal, payload and yield. Of course, detection systems (i.e., long-range radar) and the interceptor aircraft and Surface-to-Air Missiles (SAM) introduced the complication of bomber penetrability.

Subsequently, the capability to deliver nuclear weapons with missiles was developed. The Intermediate Range Ballistic Missile (IRBM), which could be deployed in countries within range of potential US and Soviet targets, was introduced by the United States in 1958. The ballistic missile with intercontinental range (ICBM) was introduced in 1959, which further complicated the analytic problem. Missile payload, reliability, and accuracy were some of the factors that had to be considered. When both the United States and the Soviet Union achieved an intercontinental ballistic missile capability, prelaunch survivability became a factor.

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*In January 1951, the United States had less than 400 nuclear weapons and 282 B-29, 195 B-50, and 38 B-36 bombers. However, not all of these 515 bombers were configured for carrying nuclear weapons.

The strategic nuclear balance analysis problem became even more complex with the addition to the Submarine-Launched Ballistic Missile (SLBM) to the Soviet nuclear arsenal in 1958 and the US arsenal in 1960. The analyst was now faced with the additional problems of alert rates, missile range, etc.

Further technological advances have led to multiple reentry vehicles, hardened silos, stand-off weapons, Anti-Ballistic Missile (ABM) systems, etc. Each of these has, in turn, introduced its own set of complexities to the problem of deriving a meaningful measure or set of measures.

Traditional Indices

Traditionally, about five or six measures have been used to compare the US/Soviet strategic balance. This paper is intended to describe those indices and explain their limitations, and the uncertainties associated with their derivation. These measures, in brief, are:

- Strategic Nuclear Delivery Vehicles--the number of missiles and bombers with a strategic nuclear delivery capability. This unit is the basis of arms-control agreements. It also forms the starting point for all other measurements and calculations.
- Total yield--the sum of the individual yield in megatons of each of the deliverable warheads (bombs and missiles).
- Warheads--the total number of individually targetable missile reentry vehicles and bombs in the inventory.
- Payload--the total weight of the weapons carried.
- Throw-weight--a measure of a missile's load-carrying capability; it is used to measure the total weight of the objects (warheads, decoys, dispensers, bus, etc.) which may be carried by the booster; the booster is meant to include the boost stages and fuel used in those stages of the missile.

The above measures were obtained by counting or summing the various units. There was little or no comparison of effectiveness of the various weapon systems. Some additional measures attempted to compare system effectiveness. One of these is:

- Range--a comparison of range capability will provide some measure of targeting capability. Today, however, US and USSR ICBMs have a range capability which allows targeting any point in the other country, but range capability does play an important part in the planning and deployment of ballistic missile submarines. Potential targets are susceptible

to attack only from such submarines in operating areas commensurate with the range of their missiles. The shorter the range of its missiles, the smaller the available operating area is for the submarine and potentially it is more vulnerable to an anti-submarine attack.

Any measure of offensive forces can be misleading without consideration of the opponent's defensive capabilities. Thus, one should address anti-air defenses, Anti-Submarine Warfare (ASW), and Anti-Ballistic Missile (ABM) assets.

- Strategic surface-to-air missile systems--the total number of surface-to-air launchers.
- Strategic air defense interceptor aircraft--the total number of aircraft assigned a strategic interceptor role.

The ASW forces and capabilities of either side were not addressed in this document because of the complexities and uncertainties involved, in addition to the classified nature of the data. The ABM treaty eliminates the necessity of a detailed comparison of the ABM systems of the United States and the Soviet Union.

Other Indices

None of the above measures or indices provides any comparison of the damage capability of the forces. Therefore, other indices have been developed which attempt to measure the strategic nuclear balance. These indices approach the analysis problem from the point of view of the effect on the target (i.e., targets killed or target damage), and attempt to equate the variety of nuclear weapon systems to simple meaningful terms.

- Equivalent Megatons (EMT)--recognizes the fact that a weapon with a 20 megaton (MT) yield does not produce twenty times the damage of a 1 MT weapon. In terms of a soft urban-industrial area target, a 20 MT weapon will destroy only a little more than seven times that of a 1 MT weapon. Analysis shows that the area subjected to a given blast over-pressure is proportional to the two-thirds power of the weapon's yield. The sum of the individual weapon's EMT of a force was defined as the force EMT and was an indication of the total soft target area which could be covered by an ideal barrage.

Since EMT only measures damage to soft area targets (e.g., cities) and is not meaningful for a comparison against hardened point targets, another index has been derived.

- Counter Military Potential (CMP)--obtained by dividing the equivalent megaton (EMT) yield of a weapon by the square of the accuracy or aiming

error (CEP^2). It is also called lethality. This measure still does not consider target hardness.

None of the above indices considers the specific characteristics of the target other than EMT, which addresses only soft urban-industrial area targets. Since targets vary greatly in terms of their vulnerability to nuclear weapon effects, a measure of strategic balance which includes target response should be considered.

The analyst has many factors which may be used, all of which will affect the comparison in varying degrees. He must consider addressing weapon characteristics (e.g., number, yield, accuracy, reliability, capability to penetrate a defensive system), targeting philosophy, target priorities, and attack objectives. A comparison of strategic forces' capabilities then includes the probability of damaging a target system to a desired level with the weapons available. The simplest of this type of measure sums and compares the numbers of a given type of target each side can damage, assuming an all-out-strike.

- Hard Target Kill Capability--a comparison of the ability of either force to destroy hardened targets. The composition and characteristics of each force are used against a given target set. The number of hardened targets which can be killed is compared.
- Surviving ICBM launchers--another example which can be utilized to portray the strategic balance is one in which the analyst calculates a first strike by one side against the other's offensive weapons. After calculating the effectiveness of the strike, he reverses the roles and recalculates. A comparison of the results of the two situations will provide an indication of both the first-strike kill capability and the number of weapons remaining for additional strikes. It will also provide an indication of the retaliatory forces available to the side suffering the initial attack. This measure, if done using appropriate target and weapon system characteristics, can provide meaningful results.

An extension of the above uses the weapons surviving a first-strike and determines the capability of these weapons in a retaliatory role.

- Retaliatory Equivalent Weapons--a measure of the effectiveness of a force against a generalized target structure after suffering a first strike. Considered in this measure are available (surviving) weapons

and their characteristics against a designated target structure with its characteristics.*

Limitations and Uncertainties

As discussed with each measure, these individual comparisons of the US and USSR strategic nuclear forces or systems have limitations and uncertainties associated with them. Therefore, they should be used carefully and with full consideration of these factors. Some measures permit only limited comparisons because they neglect to (or cannot) incorporate important aspects of the forces being compared. An accurate comparison also depends upon the accuracy and comparability of the data being analyzed. The uncertainties indicated with each measure are provided with the aim of giving an insight to the limitations of the data used. In many cases, the US perception of the Soviet capability is based upon limited observation and, in some cases, may be an interpretation and projection reflecting US capabilities.

Therefore, the user of these indices must not only be alert to their limitations and uncertainties, but he must also insure he considers them in his use of the results.

Method of Presentation

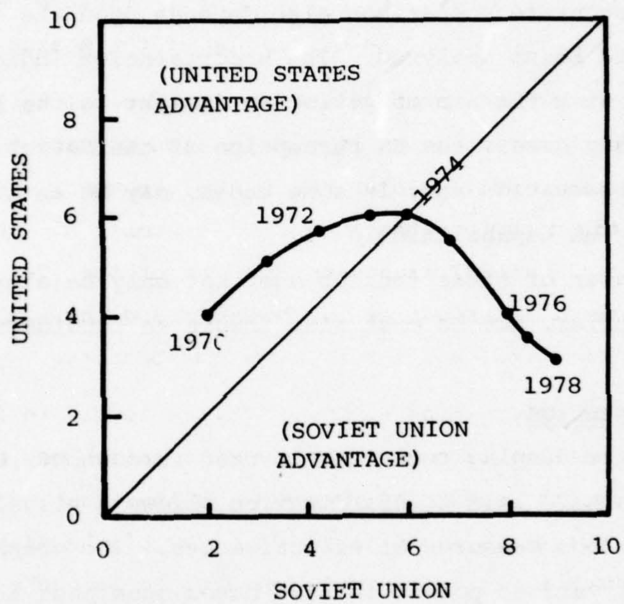
A standard graphic display technique is used throughout this report for the comparative measures. This standardization allows a visual comparison of the trends in the various measures of effectiveness. The graphs depict the US and USSR positions at various points in time based upon past and present forces. The US value is found vertically along the ordinate, with the USSR value horizontally along the abscissa. The diagonal line on each graph simply aids in visual determination of the trend. A point above or to the left of this diagonal indicates the United States has the advantage at that point in time for that measure. A point below or to the right of this diagonal indicates the advantage belongs to the Soviet Union. A point on the diagonal indicates equality with neither side having the advantage.

In the following example graph, the United States had a 2-to-1 (i.e., 4-to-2 on the graph) advantage in 1970. By 1974, although both nations show an increase, the Soviet Union has caught up to the United States (the value for

*Fred A. Payne, "The Strategic Nuclear Balance: A New Measure," Survival, Volume XX, Number 3, May/June 1977, pp. 107-110.

each is 6 and is plotted on the diagonal). After 1974, the US inventory is decreasing while the Soviet Union continues to add to its inventory and by 1976, enjoys a 2-to-1 (i.e., 8-to-4 on the graph) advantage. Additionally, the trend indicates a further advantage to the Soviet Union of 3-to-1 (i.e., 9-to-3 on the graph) by 1978.

EXAMPLE GRAPH



This method of presentation permits the data for either side to be displayed as a function of its opponents. Hence, it is possible to determine which side has an advantage without reference to more than one line. Additionally, the advantage trend is directly displayed.

SECTION 2: STRATEGIC NUCLEAR DELIVERY VEHICLES

This section compares the numbers of US and USSR strategic nuclear delivery vehicles in the two nations' inventories. Since this is a comparison of strategic force levels, those weapon systems assigned to units with a primary role other than strategic are not included. These exceptions, when they occur, are referred to in the discussion of the measure.

The first measure addresses numbers of Intercontinental Ballistic Missile (ICBM) launchers. Subsequent measures in this section compare the numbers of nuclear-powered ballistic missile submarines (SSBNs); numbers of nuclear- plus diesel-powered ballistic missile submarines (SSBs); number of Submarine-Launched Ballistic Missile (SLBM) launchers; the sum of the ICBM launchers and SLBM launchers; numbers of intercontinental bombers; and the combined total of ICBM launchers, SLBM launchers, and intercontinental bombers.

The common means of determining a nation's force levels in ICBMs and SLBMs is to count the missile launchers. Although a nation may have more missiles than launchers, the number of launchers is the limiting factor in numerical terms of an offensive capability. The size of the missiles and the damage done to the launcher during firing generally preclude the rapid reloading of modern systems. Even a "cold launch" system, wherein the missile is ejected from the silo before its booster ignites (as is attributed by some analysts to the Soviet SS-17s and SS-18s), requires an appreciable amount of time to reload. Submarines would have to return to port or at least rendezvous with a tender in a protected anchorage for reloading.

Intercontinental Ballistic Missiles

Early improvements in nuclear weapon technology permitted the development of lighter and smaller nuclear devices. These improvements were coupled with the advancing missile technology. As a result, both the United States and the Soviet Union deployed ballistic missiles as a means of delivering nuclear weapons. Both nations have had several different missile systems in their inventories over the years. Many of these were developed shortly after World War II with the help of former German missile scientists. Although there are Medium Range

Ballistic Missiles (MRBMs) and Intermediate Range Ballistic Missiles (IRBMs)* in the Soviet inventory, these weapons systems have not been included in this force comparison since they are designed, intended, and deployed for theater or tactical use. The United States has no weapons of these types.

History's first ICBM launch is believed to have occurred on August 3, 1957, when the Soviet launched an SS-6 ICBM which traveled several thousand miles before impacting in Soviet Siberia. The Soviet news Agency Tass announced that a "super-long distance, intercontinental multi-stage ballistic rocket flew at an...unprecedented altitude...and landed in the target area." The first US ICBMs, assigned to the US Air Force, became operational almost two years later, in 1959. These initial six US ATLAS-D missiles were the forerunners of today's US ICBM force of 54 TITAN II, 450 MINUTEMAN II, and 550 MINUTEMAN III missiles.

Submarine-Launched Ballistic Missiles

During the 1950s, both the US and USSR began major efforts to provide their navies with an SLBM capability. The first experimental launch of a ballistic missile from a submarine was a Soviet launch which took place in September 1955. This preceded the first submarine launchings of US POLARIS SLBM test missiles by 4-1/2 years.

The first Soviet submarines to carry SLBMs were conventionally powered (diesel) types which were converted to missile launching platforms during the period 1955-57. They were equipped with two tubes for the surface launch of the SS-N-4 SARK missile, which was a nuclear capable weapon with a range of about 300 nautical miles. Between 1958 and 1962, the Soviet Navy added 23 GOLF diesel submarines and eight HOTEL nuclear submarines to their forces.** These submarines could initially fire three of the SS-N-4 SARK missiles. Subsequently, the eight HOTELs and about half of the GOLFs were modified to carry the longer-range, underwater-launch SS-N-5 SERB missile.

*Department of Defense Dictionary of Military and Associated Terms defines ICBM ranges as 3,000 to 8,000 nautical miles; IRBM ranges as 1,500 to 3,000 nautical miles; and MRBM ranges as 600 to 1,500 nautical miles.

**Post-World War II Soviet submarine classes are assigned letter code designations by US-NATO intelligence, with the phonetic names GOLF and HOTEL being used for the letter "G" and "H" designations, respectively. One GOLF-class submarine was lost at sea in 1967.

The nuclear-propelled USS GEORGE WASHINGTON, the first US ballistic missile submarine (SSBN), went to sea on its first "deterrent patrol" on November 15, 1960. The GEORGE WASHINGTON carried 16 POLARIS A-1 missiles which could be launched from underwater. The POLARIS A-1 was armed with a nuclear warhead and had a range of 1,200 nautical miles. Forty additional 16-tube, nuclear-propelled submarines were completed by the US Navy through 1967. Their missiles were successively updated through the POLARIS A-2, POLARIS A-3, and POSEIDON C-3 missiles. Today, 10 older submarines have the 2,500-mile Multiple Reentry Vehicle (MRV) warhead A-3 missile, while 31 have been refitted with POSEIDON missiles, each carrying a nominal load of 10 Multiple Independently targeted Reentry Vehicles (MIRVs).

The Soviet SLBM force of GOLF and HOTEL submarines, plus a few older ZULU-V conversions, provided a limited capability for Soviet sea-launched strategic weapons until 1967. The first modern Soviet SSBN of the YANKEE class was launched in 1967 and was operational the following year. Through 1973, 34 of the nuclear-propelled, 16-tube YANKEE class submarines were constructed, followed by more than 25 of the larger and more-capable DELTA-class SSBNs.

Manned Bombers

The manned bomber became the first nuclear delivery vehicle when, in August 1945, B-29 SUPERFORTRESS bombers of the US Army Air Forces released atomic bombs over Nagasaki and Hiroshima, Japan. From then until the mid-1950s, the bomber was the only nuclear-capable weapon system available to either nation. In 1948, with the introduction of the B-36 bomber, the US Strategic Air Command (SAC) had a nuclear delivery vehicle which could reach targets in the Soviet Union from US bases without refueling.

The first jet-propelled B-47 STRATOJET bombers were delivered to SAC in 1951. The B-47, carrying two nuclear weapons, could achieve speeds up to 600 m.p.h., but lacked the range to reach targets in the Soviet Union from bases in the United States. As a result, large numbers of KC-97 tanker aircraft were procured to provide the B-47s with in-flight refueling, and SAC bases were established in Great Britain, Spain, and Morocco.

The US Navy began its contribution to the nation's nuclear strike capability in 1951. The new AJ SAVAGE piston-engine* aircraft began periodic

*The AJ had two piston engines and a turbojet booster.

flights from the large MIDWAY-class aircraft carriers operating in the Mediterranean Sea. This was the first US Navy nuclear-capable, carrier-based aircraft. Soon the smaller ESSEX-class carriers were fitted to handle nuclear weapons, with the AJ SAVAGE and, later, A3D SKYWARRIOR (jet) attack aircraft added to the standard carrier air groups. With the addition to the US fleet of the POLARIS submarine the attack aircraft carriers were relieved of their strategic nuclear strike role by 1962. The aircraft carriers do retain a residual nuclear strike capability.

The present US strategic bomber force is composed of the large, eight-jet B-52 STRATOFORTRESS, which was first delivered to SAC in 1955, and smaller FB-111 aircraft first delivered in 1969. The B-52 has a comparatively large weapons payload which is carried internally and on wing pylons, and the aircraft has intercontinental range. A force of KC-135 tanker aircraft is maintained to provide an air-to-air refueling capability and thereby increase the range of the bomber force.

Early in the nuclear arms race the Soviets appeared to be following the United States with the emphasis on strategic bombers. In fact, their first strategic bomber, the TU-4 BULL, was a direct copy of the B-29.* In the mid-1950's, Soviet Long-Range Aviation (LRA) began receiving the TU-16 BADGER, a swept-wing jet bomber comparable in size, role, and performance to the US B-47. A manifestation of the Soviet tendency to "build big," the BADGER has only two engines, each developing an estimated 18,180 pounds of thrust, as compared to 7,200 pounds of thrust for each of the six engines in the B-47E.

The world's only turbo-prop strategic bomber, the TU-95 BEAR, appeared a short time later, in 1955.** Soviet LRA began receiving the BEAR and the four-jet MYA-4 BISON bombers in 1956. However, the long intercontinental flight distances to US targets, and the need to over-fly Canada, where warning and intercept systems could be based, limited the strategic effectiveness of these aircraft. Recognition of these limitations were instrumental in the Soviet decision to develop strategic missiles, both ICBMs and SLBMs, thereby opting for other means of delivery for their nuclear weapons.

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*Names of Soviet aircraft used herein (e.g. BULL) are of NATO origin.

**The Soviet military designation for this aircraft is TU-20. US publications generally identify the BEAR as the TU-95, which is the Tupelov design bureau designation.

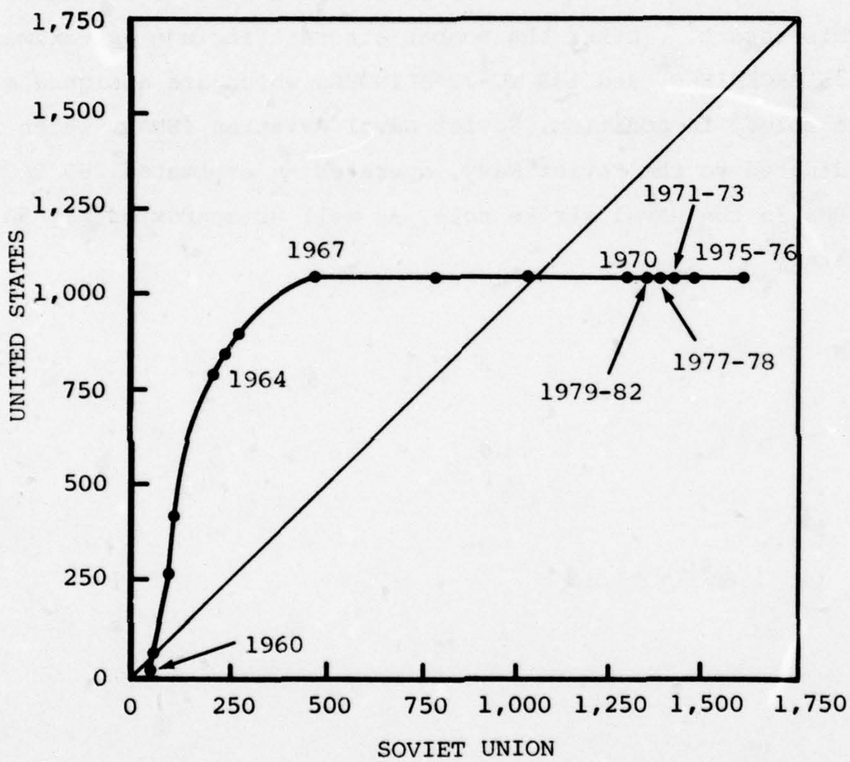
In 1973, the supersonic BACKFIRE bomber was introduced by the Soviets. Although US Department of Defense technical assessments of the BACKFIRE's performance indicate that this aircraft has an intercontinental capability, the Soviet contention is that the BACKFIRE is a medium bomber intended for peripheral/theater missions. Therefore, according to the Soviets, the present LRA strategic bomber force consists only of BEAR and BISON aircraft, and unless otherwise noted, those are the only Soviet strategic bomber aircraft included in this report. (Other LRA bomber aircraft include approximately 300 BADGERs, 35 BACKFIREs, and 135 TU-22 BLINDERs which are assigned a theater strike role. In addition, Soviet Naval Aviation (SNA), which is totally subordinated to the Soviet Navy, operates an estimated 280 BADGERs and 30 BACKFIREs in the naval strike role, as well as approximately 50 BLINDER aircraft.)

MEASURE 1

Intercontinental Ballistic Missile (ICBM) Launchers

What it Measures

The number of fixed Intercontinental Ballistic Missile (ICBM) launchers is totaled, regardless of status.



Limitations

- Counting the number of ICBM launchers does not take into consideration system or individual missile effectiveness. In this measure a missile with a yield of 5 MT and an accuracy of 0.5 n.m. is considered the same as a missile with a yield of 200 KT and a CEP of 1 n.m. Factors such as prelaunch survivability, hardness to nuclear effects, number of warheads, etc., are also not considered by this measure.
- At any given time some ICBM launchers are not operational, but are being upgraded, replaced, etc. At the same time, some additional

launching sites may not have operational missiles in place. As a result, this count tends to overstate the usable force size.

- Mobile launchers which may have intercontinental ranges are not counted by this measure.
- This measure counts fixed ballistic missile launchers with intercontinental range. It disregards those deployed MRBMs and IRBMs which, because of their advanced basing, may have the capability of reaching another nation's homeland.

Uncertainty

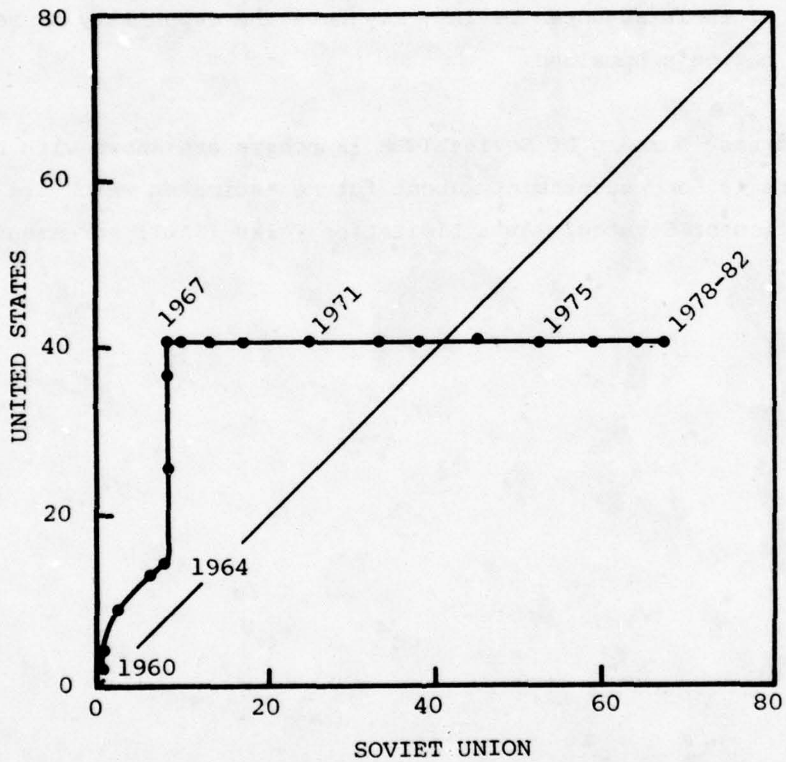
Current and past numbers of Soviet ICBM launchers are known with reasonable certainty. There is some uncertainty about future estimates which are based upon the assumption of Strategic Arms Limitation Talks (SALT) agreement.

MEASURE 2

Nuclear-Powered Ballistic Missile Submarines

What it Measures

The number of nuclear-powered ballistic missile submarines (SSBN) is totaled.



Limitations

- This measure, by simply totaling SSBNs, treats all such submarines the same and thereby disregards the individual submarine capabilities. Factors such as numbers of launching tubes, missile characteristics, etc., are also not considered by this measure.
- At any given time some SSBNs are undergoing overhaul, in transit, in a training cycle, etc., and therefore are not available or in position for launching their missiles. As a result, this measure tends to overstate the usable force size.

Uncertainty

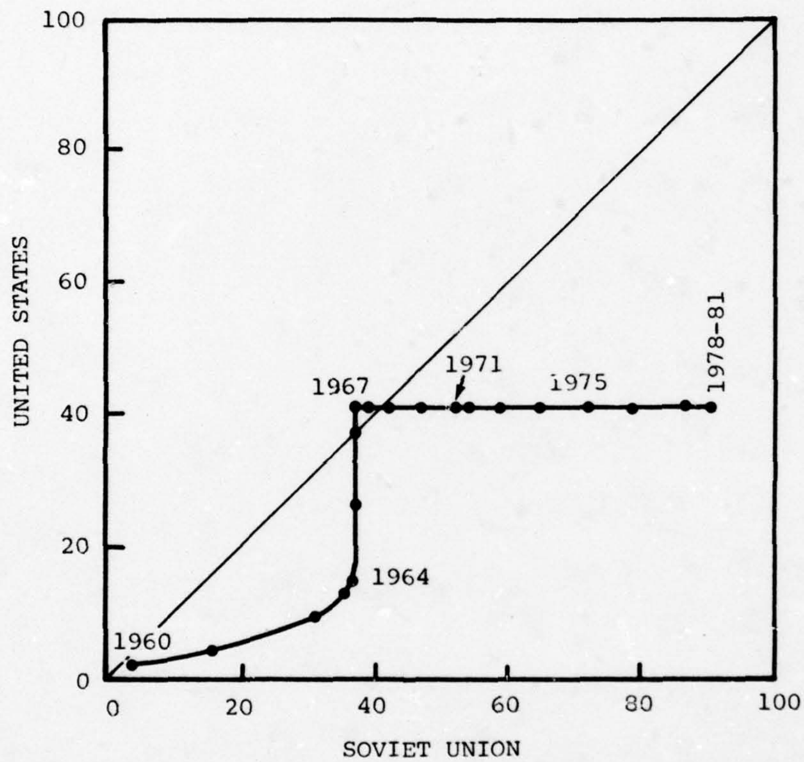
Current and past numbers of Soviet SSBNs are well known. There is some uncertainty about future estimates which are based upon the assumption of Strategic Arms Limitation Talks (SALT) agreement. These future numbers could vary depending upon Soviet options and decisions to place more reliance on SLBMs.

MEASURE 3

Nuclear- and Diesel-Powered Ballistic Missile Submarines

What it Measures

The number of nuclear-powered plus diesel-powered ballistic missile submarines (SSBNs plus SSBs) is totaled.



Limitations

- This measure, by simply totaling SSBNs and SSBs, treats all such submarines the same and thereby disregards the individual submarine capabilities. The older, less capable diesel submarine is counted the same as the newer, more capable nuclear submarine. Factors such as numbers of launching tubes, missile characteristics, etc., are also not considered by this measure.
- At any given time some submarines are undergoing overhaul, in transit, in a training cycle, etc., and therefore are not available or in

position for launching their missiles. As a result, this measure tends to overstate the usable force size.

Uncertainty

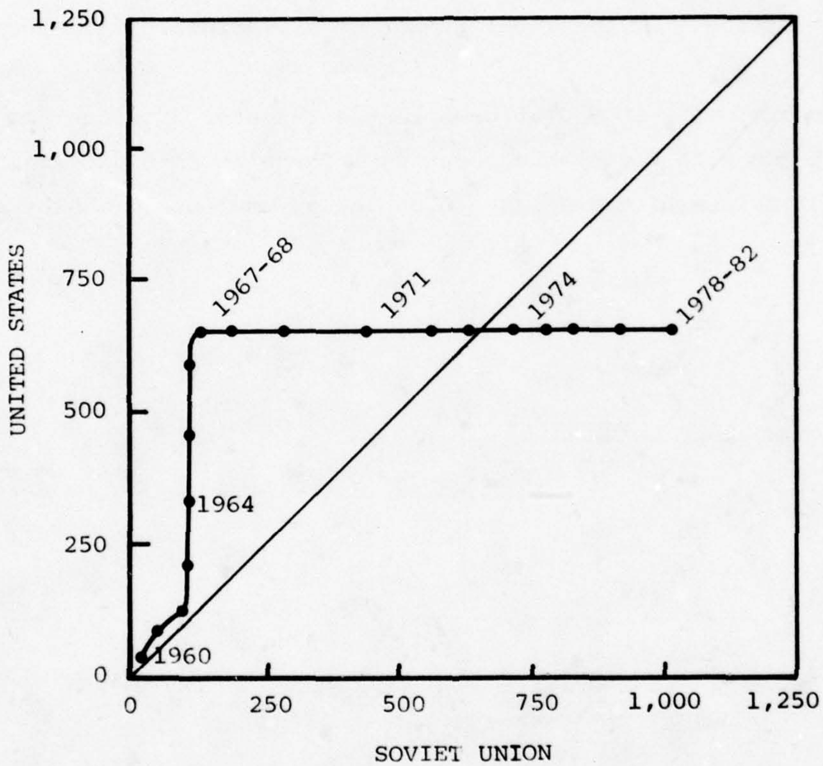
Current and past numbers of Soviet ballistic missile submarines are well known. There is some uncertainty about future estimates which are based upon the assumption of a SAL agreement. These future numbers could vary depending upon Soviet options and decisions to place more reliance on SLBMs.

MEASURE 4

Submarine-Launched Ballistic Missile (SLBM) Launchers

What it Measures

The number of Submarine-Launched Ballistic Missile (SLBM) launchers is determined by counting the number of ballistic missile submarines by type and totaling the number of SLBM launching tubes. For example, each POLARIS and POSEIDON submarine is counted as 16 (i.e., the number of SLBM tubes).



Limitations

- Counting the number of launching tubes in ballistic missile submarines does not take into consideration individual system effectiveness. For example, with this measure a launching tube in a Soviet DELTA-class SSBN and a launching tube in a Soviet HOTEL-class SSBN are considered equal. This has the result of treating a longer-range SLBM the same as a much shorter-range missile. Factors such as pre-launch survivability, hardness to nuclear effects, alert rate, MIRV capability,

reliability, accuracy, etc., are also not considered.

- This measure does not consider the type of submarine which has the SLBM tubes. For example, each tube in a nuclear powered submarine is treated in the same manner as one in a conventionally powered submarine.
- This measure does not consider submarine deployments. It disregards the number of submarines on station, in transit, undergoing overhaul, etc., counting only the total number of submarines.

Uncertainties

The number of Soviet SLBM platforms in the inventory for current and past years is known with reasonable accuracy. There is some uncertainty about future estimates which are based upon the assumption of a SALT agreement.

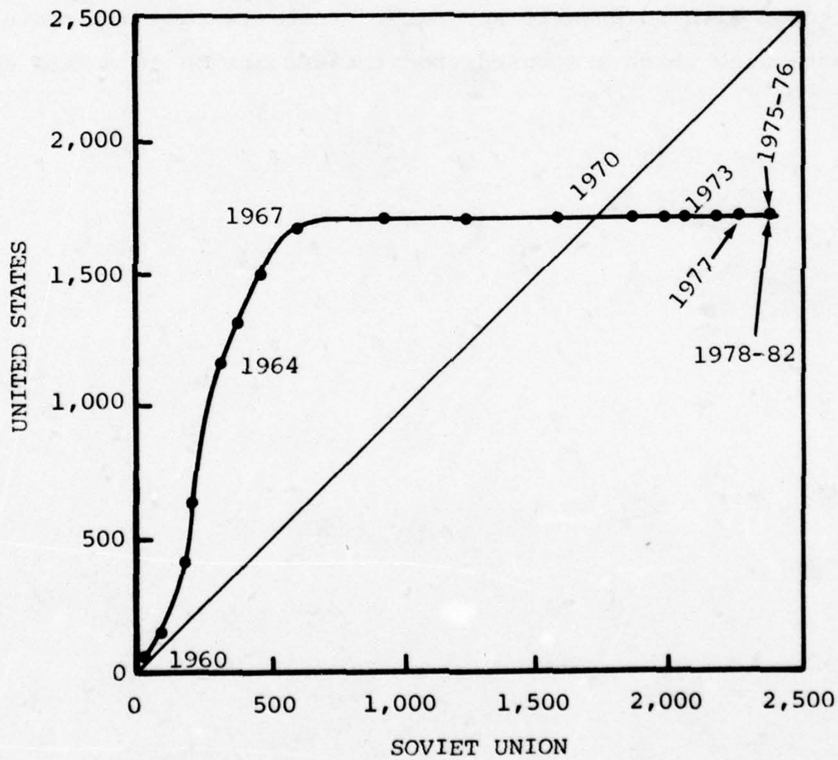
MEASURE 5

Intercontinental Ballistic Missile Launchers and

Submarine-Launched Ballistic Missile Launchers

What it Measures

The number of ICBM and SLBM launchers is totaled (i.e., this measure is the summation of two previous measures, Intercontinental Ballistic Missile Launchers and Submarine-Launched Ballistic Missile Launchers). This measure is an indication of the total number of strategic ballistic missiles available to each nation.



Limitations

- This measure, being the summation of two other measures (i.e., Intercontinental Ballistic Missile Launchers and Submarine-Launched Ballistic Missile Launchers), incorporates all of the limitations of those two measures.

- The measure, by treating both ICBMs and SLBMs in the same manner, has the additional limitation of treating the inherently shorter-range, less accurate, lower yield, SLBM missile as the equal of the longer-range, more accurate ICBMs.

Uncertainty

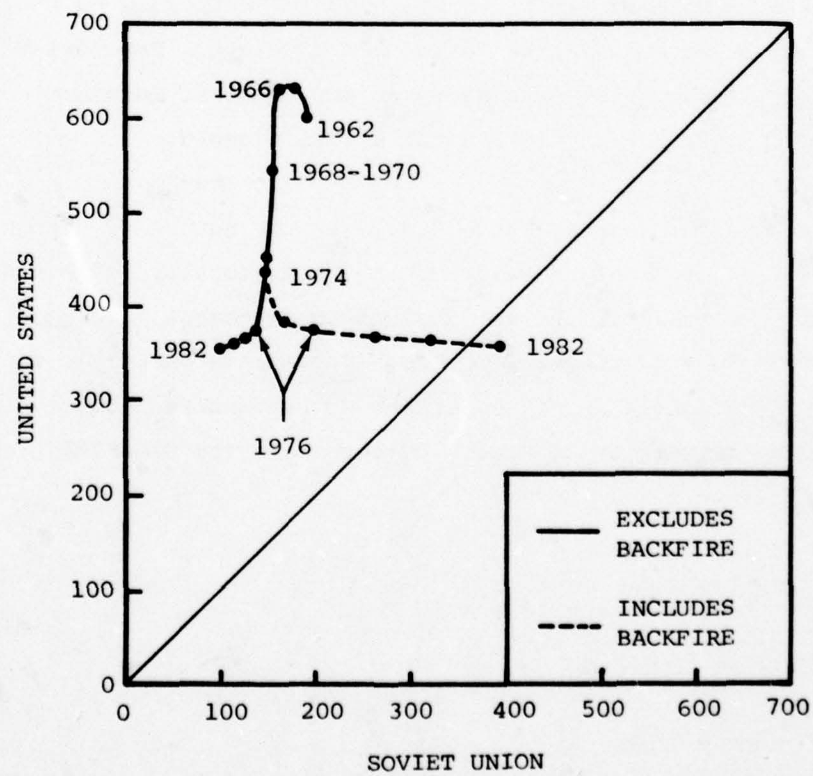
This measure, being the summation of two other measures (i.e., Intercontinental Ballistic Missile Launchers and Submarine-Launched Ballistic Missile Launchers), incorporates all of the uncertainties of those two measures.

MEASURE 6

Intercontinental Bombers, Inventory

What it Measures

The number of intercontinental bombers is totaled. At Vladivostok in 1974 it was agreed that "heavy bombers" would be included in the aggregate limitation of strategic nuclear delivery vehicles. Just what bombers fit into the definition of "heavy bombers" was not determined by the accord. It is the Soviet contention that the BACKFIRE is a medium bomber intended for peripheral/theater missions and should therefore not be counted. US Department of Defense technical assessments of the BACKFIRE performance indicate that this aircraft has the capability of intercontinental missions against the United States. For that reason, two lines are shown after 1974. The solid line includes US B-52 aircraft and Soviet TU-95 BEAR and MYA-4 BISON aircraft only. The dashed line adds the Soviet BACKFIRE bomber.



Limitations

- This measure, by counting the number of intercontinental bombers, disregards the number of aircraft actually available to fly missions. That is the number of aircraft which are operationally ready and which might survive any prelaunch strike.
- This measure does not include bomber force characteristics such as range, weapon mixture, payload capability, penetration capability, delivery accuracy, etc.
- Shorter range bombers such as the US FB-111, which are capable of intercontinental missions with in-flight refueling, are not counted in this measure.
- US fighter-bombers which are stationed in Europe, which have the capability of striking western portions of the Soviet homeland, are not included in this measure. In a similar manner, US Navy carrier-based aircraft have not been included in this measure.
- The Soviets also have approximately 45 BISON aircraft that have been converted from bombers to tankers and approximately 65 BEAR aircraft configured as reconnaissance and ASW aircraft. The Soviets could choose to convert these bomber variant aircraft into bombers. These aircraft have not been included in this measure.

Uncertainties

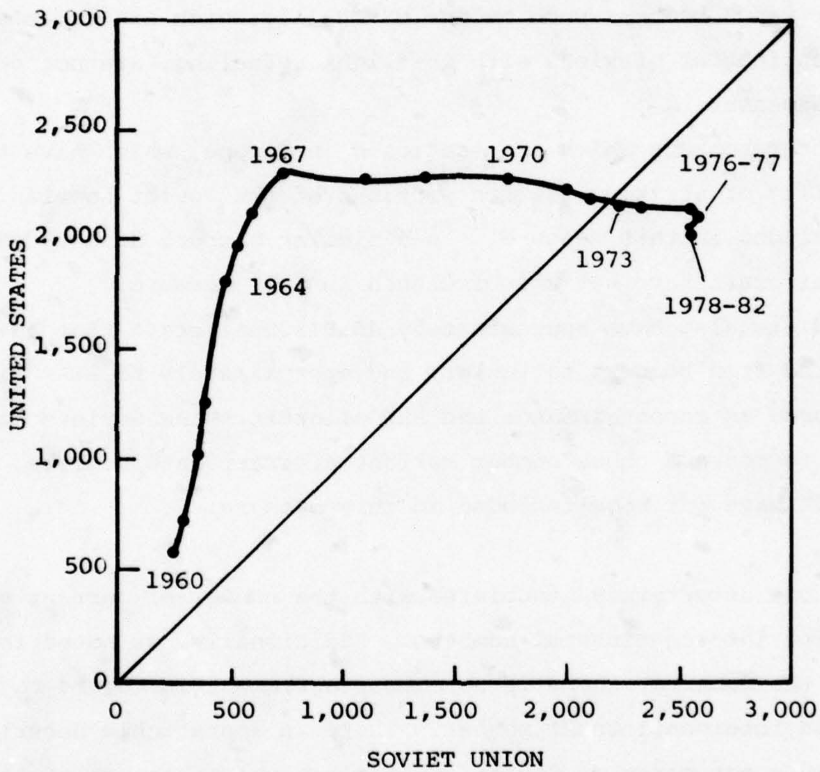
There is some uncertainty associated with the number of current and past numbers of Soviet intercontinental bombers. Additionally, as noted in the description of the measure, there is no common agreement in regard to the definition of an intercontinental bomber. There is appreciable uncertainty relative to future estimates of Soviet strategic bombers because of the disagreement in the definition of "heavy bombers" and the BACKFIRE production rate.

MEASURE 7

Strategic Offensive Delivery Vehicles, Inventory

What it Measures

The number of ICBM launchers, SLBM launchers, and intercontinental bombers in the inventory is totaled. For example, an ICBM with 4 independently targetable warheads, an SLBM with 5 independently targetable warheads, and a B-52 with 12 SRAM are each counted as one by this measure. As another example, a B-52 with 4 bombs is also counted as one by this measure.



Limitations

- This measure, being the summation of three previous measures (i.e., Intercontinental Ballistic Missile Launchers; Submarine-Launched Ballistic Missile Launchers; and Intercontinental Bombers, Inventory), incorporates all of the limitations of those three measures.
- The measure, by treating ballistic missile launchers the same, has the additional limitation of treating the shorter range, less accurate, SLBM missile as the equal of the intercontinental range, more accurate ICBMs.

- The measure has the further limitation of treating bombers the same as ballistic missiles.
- The measure is assumed to have a limitation of 2,400 delivery vehicles after 1976 in accordance with the Vladivostok Accord of 1974.

Uncertainties

This measure, being the summation of three previous measures (i.e., Intercontinental Ballistic Missile Launchers; Submarine-Launched Ballistic Missile Launchers; and Intercontinental Bombers, Inventory), incorporates all of the uncertainties of those three measures.

SECTION 3: INDEPENDENTLY TARGETABLE WARHEADS

This section compares the number of independently targetable warheads in the US and USSR strategic inventories. Prior to 1968 strategic missiles were equipped with only one warhead. Therefore, a count of ICBMs or SLBMs was a relatively simple matter and gave a useful indication of the ballistic missile nuclear strike capability of a nation.

The United States began deployment of the first multiple warhead ballistic missile when, in 1964, the POLARIS A-3 submarine-launched missile became operational. This variant of the POLARIS missile has a range of 2,500 nautical miles and carries a Multiple Reentry Vehicle (MRV) payload. After launch, this missile's payload separates into three separate RVs which attack a single target in a fixed pattern. The USS DANIEL WEBSTER was the first POLARIS submarine armed with the MRV A-3 missiles. From 1964 on, most of the US Navy's 41 ballistic missile submarines were rearmed with this multiple-warhead missile.

The next logical step in weapon technology was development of the capability to deliver each of the individual warheads independently, against different targets. When the A-3 with its three MRVs went to sea, development was already underway on Multiple Independently targeted Reentry Vehicle (MIRV) warheads. With this type of weapon system, the rocket boosters carry a "bus" which contains several RVs. After the boosters burn out and separate from the "bus," the latter continues toward enemy territory, dispensing the RVs on a preset program. Each RV can be aimed at a separate target (i.e., independently targeted) within a given area of land or "footprint." The weapon's footprint is dependent upon missile range, the characteristics of the bus dispensing mechanism, and any maneuvering that may be done by the bus. Therefore the footprint is obviously limited and targets must be chosen accordingly.

The first operational tests of a MIRV system began in 1968 with the US MINUTEMAN III ICBM. This MIRV system, with three RVs, replaced 550 of the earlier MINUTEMAN I and II single warhead missiles in the SAC arsenal between 1970 and 1975.

In 1970, the US Navy fired the first submarine-launched MIRVed missile, the POSEIDON C-3. This weapon can deliver up to 14 RVs, has a reported range of 2,500 nautical miles with a lesser payload, and is the successor to the POLARIS missile. Between 1970 and mid-1977, the Navy converted 31 POLARIS submarines to carry the MIRVed POSEIDON missiles. (The ten oldest POLARIS

submarines are not suitable for modification and still carry the A-3 missile.)

The US has no monopoly on technological development of strategic weapons and in 1968 the USSR began testing the SS-9 SCARP with a MRV warhead. This was followed in the mid-1970s by the development and deployment of MIRVed warheads on the SS-17, SS-18, and SS-19 ICBMs.

Subsequently, the Soviet Navy's YANKEE-class submarines have been credited with carrying the SS-N-6 Mod 3 missile, carrying 2 or 3 MRVs, and the DELTA-class submarines can fire the SS-NX-18 and probably later SLBMs with MIRV payloads. The latter missiles, with a range significantly in excess of 4,000 nautical miles, are equivalent or superior in that respect to the US Navy's TRIDENT I SLBM, which should be deployed about 1980-1981, and the proposed TRIDENT II missile, which could become available in the mid-1980s, at the earliest.

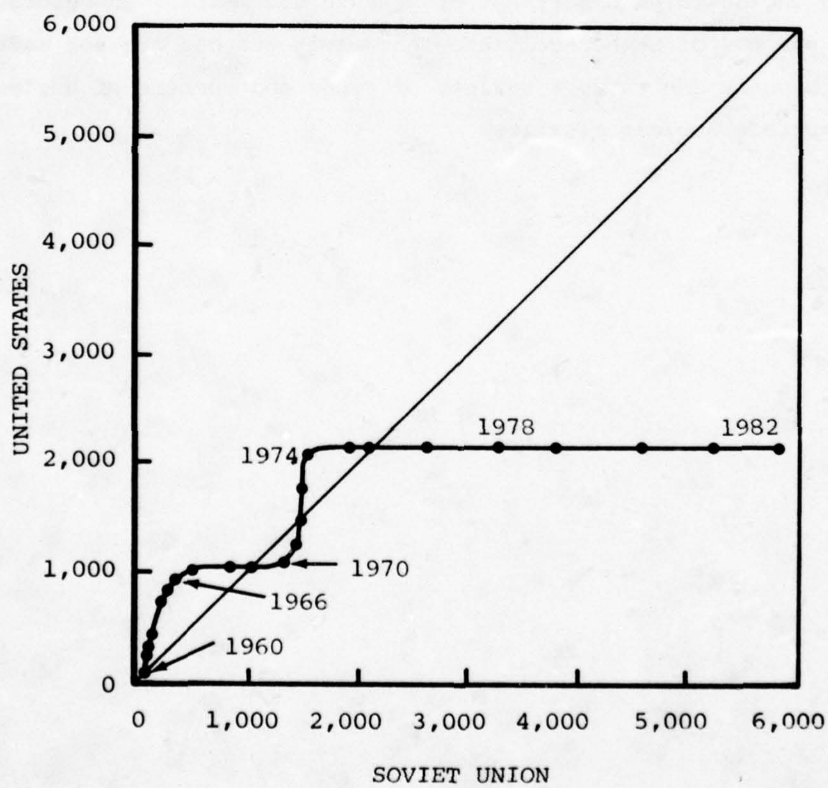
US strike-configured strategic bomber operational weapon loadings are not contained in unclassified Department of Defense documents. Therefore, comparisons of the numbers of bomber-deliverable nuclear weapons are not made. Both US and USSR bombers can carry a variety of types and numbers of nuclear bombs and air-to-surface nuclear missiles.

MEASURE 8

Independently Targetable ICBM Warheads, Inventory

<u>What it Measures</u>

The number of Independently Targetable Reentry Vehicle (MIRV) warheads associated with ICBM boosters is counted. For example, an ICBM with three Multiple Independent Reentry Vehicles (MIRVs) is counted as 3 in this measure, whereas another ICBM with one warhead is counted as 1. As another example, an ICBM with three MRVs, separate reentry vehicles which are delivered in some pattern about a single aim point, is counted as 1. An ICBM which is not operational because it is under conversion or upgrade is also counted. In a sense then, this is a measure of the number of separate aim points an ICBM force could target were all of its missiles operational.



Limitations

- Counting the number of independently deliverable ICBM warheads does not take into consideration system or individual reentry vehicle effectiveness. Thus, a 20 MT RV and a 100 KT RV are considered equal in this measure. Factors such as prelaunch survivability, reliability, hardness to nuclear effects, accuracy of delivery, etc., are not included.
- The total number of reentry vehicle warheads is based upon our perception of the number of missile launchers.
- A portion of the Soviet missile sites are undergoing upgrade or conversion at any time. Hence, our estimate of what independent reentry vehicle warheads may be associated with these sites and our knowledge of the number of launching sites in such a status affects the total number of RV warheads calculated.

Uncertainties

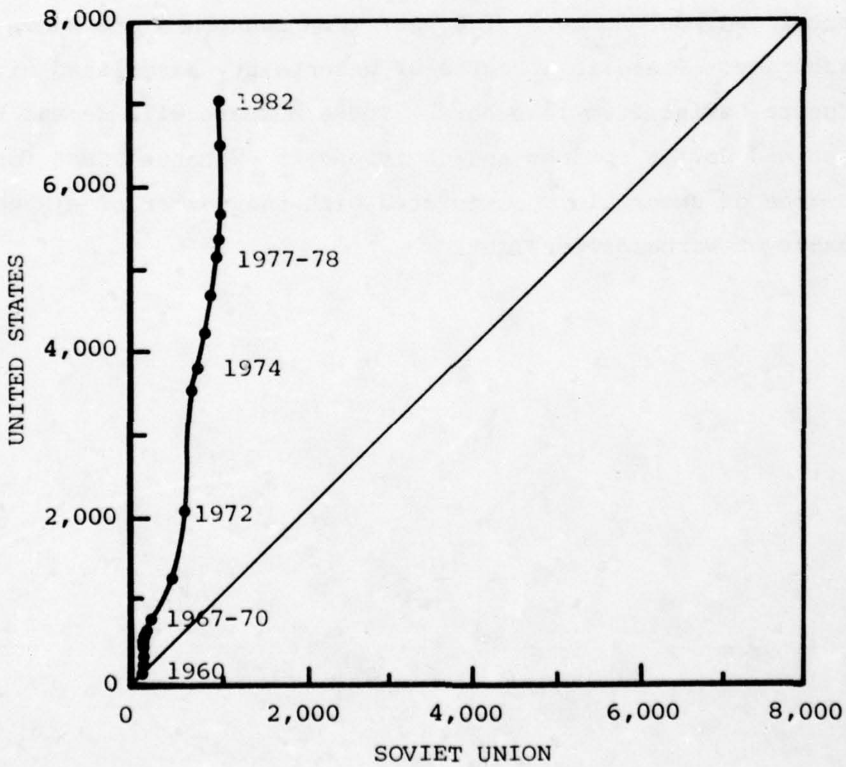
The current and past numbers of Soviet ICBM launchers are known with reasonable accuracy. There is a degree of uncertainty associated with the numbers of future Soviet ICBM launchers. These numbers will depend upon any SALT agreement and Soviet options and decisions to exchange ICBMs for SLBMs. There is a degree of uncertainty associated with the number of MIRVed Soviet ICBMs and number of warheads per ICBM.

MEASURE 9

Independently Targetable SLBM Warheads, Inventory

What it Measures

The number of independently targetable Reentry Vehicle (RV) warheads associated with Submarine Launched Ballistic Missiles (SLBMs) is counted. For example, an SLBM with 3 separate RVs which are delivered in some pattern about a single aim point is counted as 1, whereas another SLBM with one warhead is counted as 1. As another example, an SLBM with 5 MIRVs is counted as 5. SLBM tubes on board submarines which are in conversion and/or overhaul and not on station are included in the count. In a sense then, this is a measure of the number of separate aim points an SLBM force could target were all of its missiles operational and were all of its submarines within launching range.



Limitations

- Simply counting the number of independently deliverable SLBM warheads does not take into consideration system or individual reentry

vehicle effectiveness. Thus, a 1 MT RV and a 50 KT RV are considered equal by this measure. Factors such as prelaunch survivability, reliability, accuracy of delivery, SLBM range, and numbers of submarines on station are not included in the measure.

- The number and type of SLBM submarines is not considered by the measure.

Uncertainties

The number of Soviet SLBM platforms (and hence number of boosters) in the inventory for current and past years is known with reasonable accuracy. The estimates of future numbers of Soviet SLBMs could vary depending upon a SALT agreement and Soviet options or decisions to replace ICBMs with SLBMs.

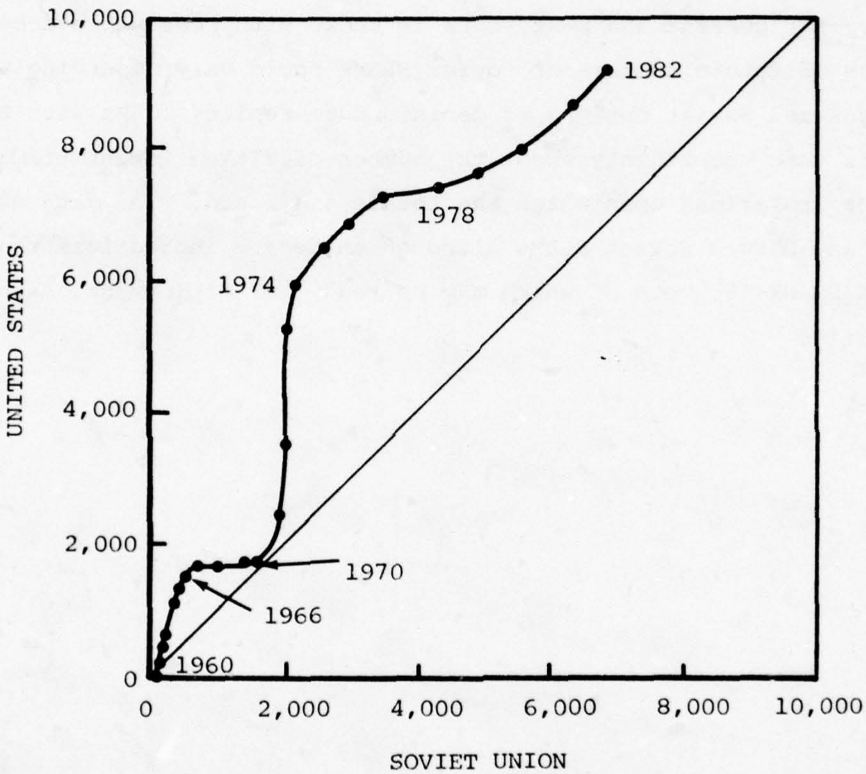
There is some uncertainty about the number of MIRVed Soviet SLBMs which affects the calculations upon which the totals are based. The data used did not include any MIRVed Soviet SLBMs although there are indications that the SS-NX-17 and SS-NX-18, both of which may be ready for deployment, each have a MIRV capability.

MEASURE 10

Independently Targetable ICBM and SLBM Warheads, Inventory

What it Measures

The number of independently targetable reentry vehicles associated with ICBMs and SLBMs in the inventories is totaled. In a sense, this measure totals the number of separate aim points which could be targeted by an ICBM, SLBM force were all of its missiles operational.



Limitations

- This measure, being the summation of two previous measures (i.e., Independently Targetable ICBM Warheads, Inventory and Independently Targetable SLBM Warheads, Inventory), incorporates all of the limitations of those two measures.
- The measure, by treating warheads the same, has the additional limitation of treating the shorter range, less accurate, SLBM as the equal of the intercontinental range, more accurate ICBM.

Uncertainties

This measure, being the summation of two previous measures (i.e., Independently Targetable ICBM Warheads, Inventory and Independently Targetable SLBM Warheads, Inventory), incorporates all of the uncertainties of those two measures.

SECTION 4: ICBM THROW-WEIGHT

This section compares the throw-weight of the US and USSR inventories. Throw-weight includes the weight of the warhead(s), any penetration aids, dispensing mechanism, bus, fuel used for maneuvering, etc. It reflects the weight throwing capacity of a ballistic missile and is, therefore, a measure of the weight of that part of the missile above the last boost stage.

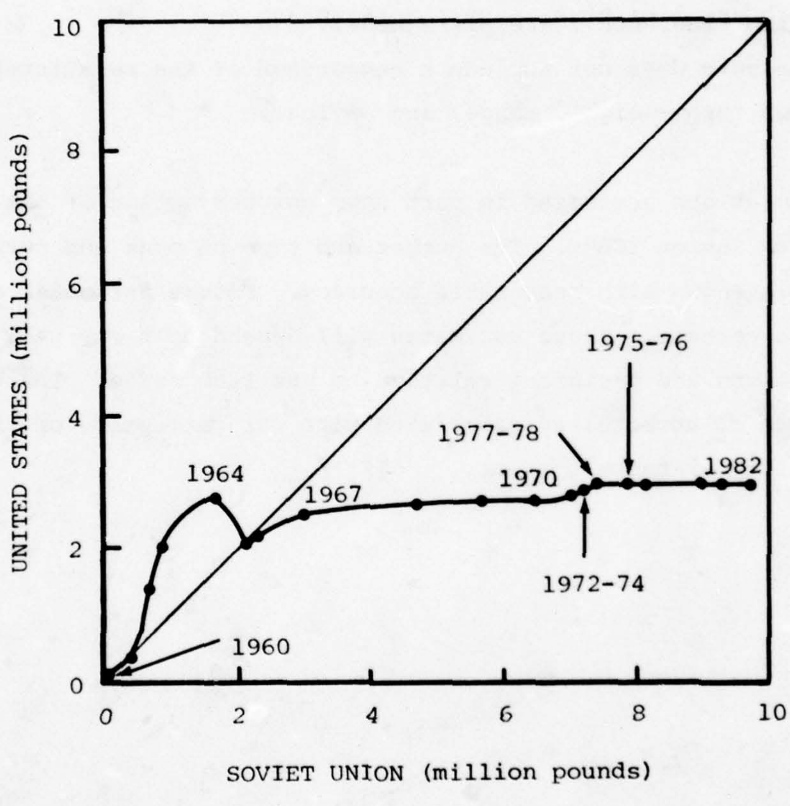
Since throw-weight is generally related to missile size, a comparison of SLBMs which are limited by submarine size was not included.

MEASURE 11

ICBM Throw-weight, Inventory

What it Measures

The throw-weight of all ICBMs in the inventory is totaled for this measure.



Limitations

- A missile which has either Multiple Reentry Vehicles (MRV) or Multiple Independently targeted Reentry Vehicles (MIRV) has a significant amount of weight devoted to the mechanisms necessary to place the reentry vehicle into the proper attitude, etc., for reentry. Therefore, total inventory throw-weight tends to overstate the total deliverable warhead weight.

- The calculations presented in this measure are based upon the premise that all weapons are reliable. This, of course, is not the case. Additionally, at almost any time some proportion of a nation's ICBM force is not operational. An ICBM may be off line for such reasons as testing, maintenance, upgrade, or conversion. Hence, the measure tends to overstate the total throw-weight of both nations.
- The measure does not include other factors of ICBM system and missile effectiveness. For example, weapon yield, accuracy, silo hardness, reaction time, etc., are disregarded.
- The measure does not include a comparison of the relationships between throw-weight, range, and payload.

Uncertainties

The calculations are based in part upon our perception of the throw-weight associated with Soviet ICBMs. The number and type of past and current Soviet ICBM systems is known with reasonable accuracy. Future estimates of Soviet ICBMs are less certain. These estimates will depend upon any SALT agreement and Soviet options and decisions relative to the ICBM force. There is a significant degree of uncertainty associated with our perception of the throw-weight capability of these systems.

SECTION 5: SLBM MAXIMUM RANGE

The maximum range of SLBMs in one force is compared to the maximum range of SLBMs in the other force.

This comparison provides an indication of both potential target coverage and size of submarine operating area. The longer the range of the SLBMs the wider the choice of targets from a given operating area or, conversely, for the same target set the potential operating area increases.

The total ocean area is about ten times the total combined land area of the United States and the Soviet Union. If the range of SLBMs in either nation's arsenal permits the use of only 10% of the total ocean area as ballistic missile submarine operating area, the Anti-Submarine Warfare (ASW) problem is terrific. On the average, if all submarines were on station, each submarine would have over 150,000 square miles of ocean in which to hide.

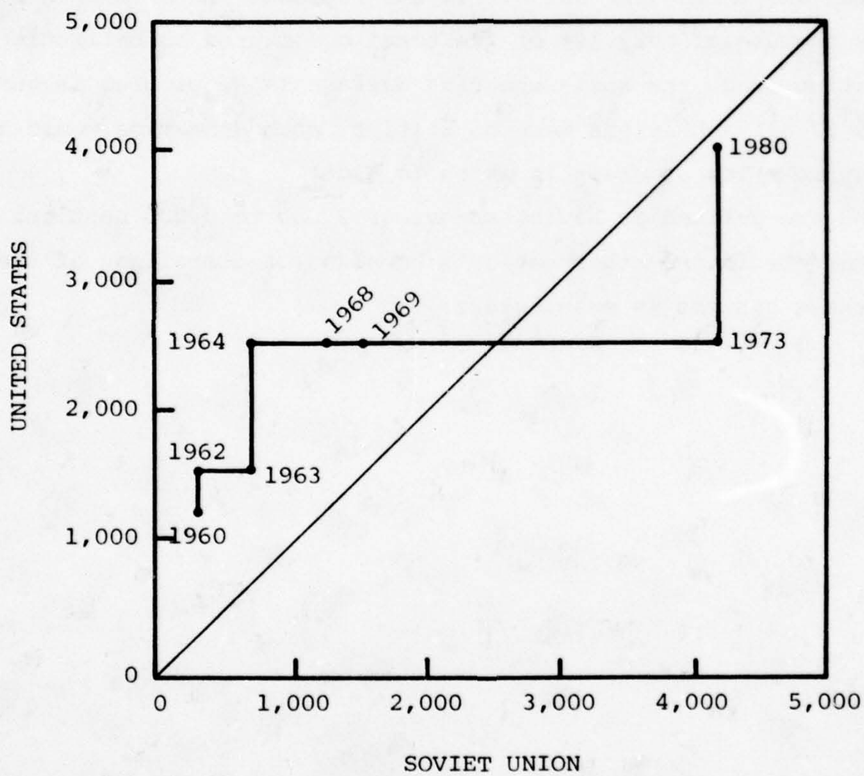
Since ICBMs are defined as having ranges of 3,000 to 8,000 nautical miles, and can reach targets in the other nation's homeland, a comparison of the range capability of these systems is meaningless.

MEASURE 12

SLBM Maximum Range

What it Measures

The maximum range of one nation's SLBMs is plotted against the maximum range of the other nation's SLBMs. For example, in 1973 the Soviet Union introduced the 4,200-plus nautical mile SS-N-8 SLBM. At that time the POSEIDON C-3 missile, with a nominal range of 2,500 nautical miles, was the longest range US SLBM.



Limitations

- This measure displays the ranges of the two nations' longest range SLBMs. Since the newest SLBM is most often a nation's longest range SLBM, the measure is sensitive to introduction of new SLBMs. As a result of this limitation, a false picture of the balance is portrayed. For the 1973 example cited above, when the measure appears to have shifted to the Soviet's favor it must be considered that the Soviets

had only one or two submarines with the new longer range missile, while the entire US force was capable of attacks to approximately 2,500 n.m.

- The measure disregards other measures of SLBM force effectiveness such as alert rate, accuracy, yield, etc.

Uncertainties

There is some uncertainty associated with the year of introduction of Soviet SLBM systems. There is a greater degree of uncertainty as to the maximum range of Soviet SLBM systems.

SECTION 6: GROSS YIELD

This section compares the total nuclear yield of the strategic missile forces. The first measure addresses the gross yield of the ICBM forces. This is followed by a comparison of the gross yield of the SLBM forces and then the sum of the gross yields of the ICBM and SLBM forces.

Yield of nuclear weapons is a measure of the explosive energy that can be released by the weapon. It is common practice to state this in terms of the equivalent quantity of TNT required to produce the same explosive force. Thus, a yield of one kiloton (KT) is equivalent to 1,000 tons of TNT. One megaton (MT) is equivalent to 1,000,000 tons of TNT or 1,000 KT. The nuclear weapons exploded over Nagasaki and Hiroshima in 1945 had yields of approximately 20 KT. Most early strategic missiles had yields measured in the megaton range. Technological improvements have increased the delivery accuracy while MRV and MIRV systems have decreased the available weight for individual warheads using the same boosters. These two facts, in other words, first enabled and then required smaller yield weapons so that today the individual warhead yield of many strategic systems has been reduced and is measured in kilotons.

A comparison of gross yield capabilities of strategic bomber forces has not been included in this section. There are several reasons for this. First, aircraft bomb load is in part dictated by the amount of fuel carried by the aircraft. Secondly, there is a large variety of bombs and missiles that can be carried by bombers. Hence, any aircraft loading is mission rather than design oriented and any comparison of gross yield capabilities of aircraft would not be meaningful.

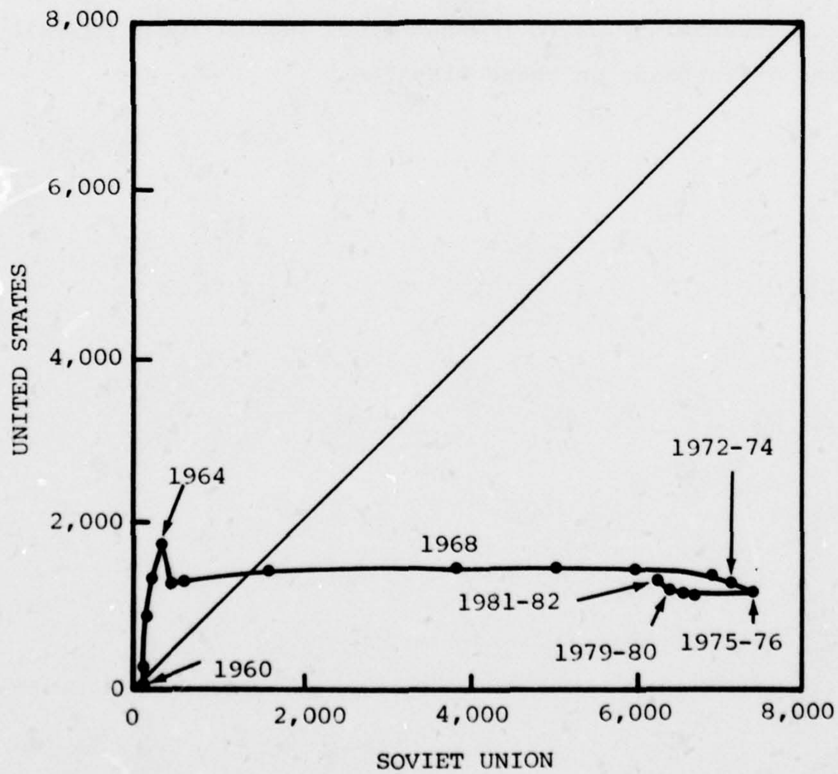
MEASURE 13

ICBM Gross Yield, Inventory

What it Measures

The yield of ICBM warheads is totaled. For example, if an ICBM force consisted of two ICBMs each with a single 5 MT warhead, two ICBMs with three MRVs of 1 MT, and one ICBM with ten 200 KT MIRVs, the total yield in MT is counted as 18 in this measure. That is:

MISSILES	WARHEADS PER MISSILE	YIELD PER WARHEAD (MT)	TOTAL SYSTEM YIELD (MT)
2	1	5	10
2	3	1	6
1	10	0.2	2
		TOTAL YIELD	18



Limitations

- Totaling the yield of ICBM warheads does not take into consideration system or individual reentry vehicle effectiveness. For example, under this measure a single 5 MT reentry vehicle warhead with a delivery accuracy of 0.5 n.m. is considered equal to five other warheads each of which has a yield of 1 MT and an accuracy of 0.25 n.m. Factors such as prelaunch survivability, reliability, hardness to nuclear effects, accuracy of delivery, independent targetability, etc., are not considered by this measure.
- The total value (gross yield) of Soviet ICBMs is based upon our perception of the type and number of observed ICBM launching sites.

Uncertainties

While there is little uncertainty associated with current and past numbers of Soviet ICBM launchers, there is a degree of uncertainty associated with the type and yield of the warheads associated with specific ICBM systems.

Since some of the Soviet ICBM systems are deployed in different configurations, there is uncertainty as to the number of MIRVed ICBMs as well as the yield and number of warheads on these missiles.

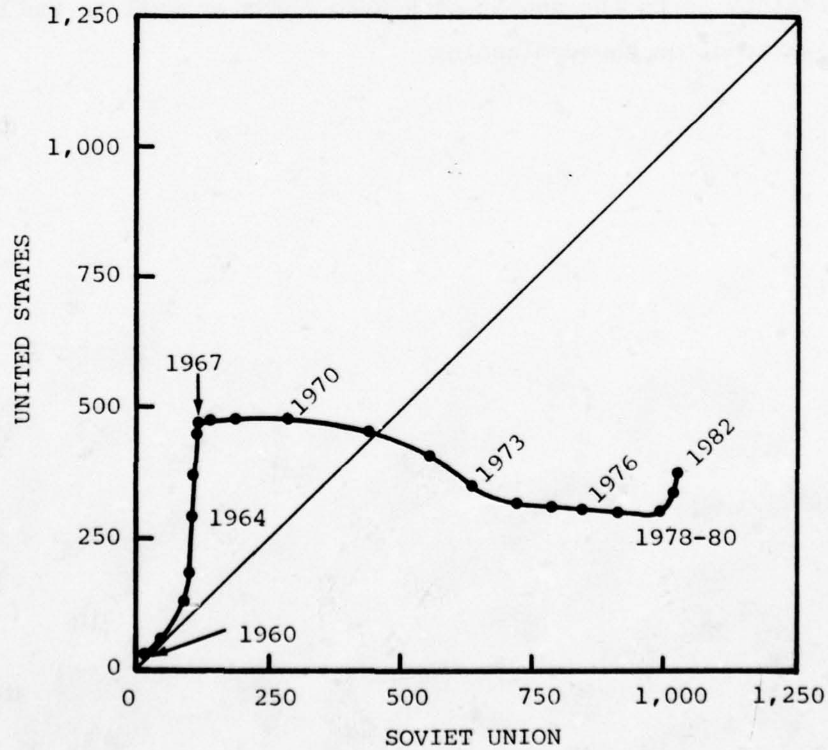
MEASURE 14

SLBM Gross Yield, Inventory

What it Measures

The yield of SLBM warheads is totaled. Only vertical tube SLBM launchers are counted. For example, if an SLBM force consisted of one submarine with 16 launchers each with an SLBM with a single 1.5 MT warhead, two submarines each with 12 SLBMs with three MRVs of 1 MT, and one submarine with 16 SLBMs with five 50 KT MIRVs, the total yield in MT is counted as 100 in this measure. That is:

SUBMARINES	LAUNCHING TUBES/SLBMS	WARHEADS PER MISSILE	YIELD PER WARHEAD (MT)	TOTAL YIELD (MT)
1	16	1	1.5	24
2	12	3	1	72
1	16	5	0.05	4
			TOTAL	100



Limitations

- Totaling the yield of SLBM warheads does not take into consideration system or individual reentry vehicle effectiveness. For example, under this measure, four missiles with five 50 KT reentry vehicle warheads each and a delivery accuracy of 0.25 n.m. are considered equal to one missile with a yield of 1 MT and an accuracy of 1 n.m. Factors such as submarines on station and weapon range, prelaunch survivability, reliability, hardness to nuclear effects, accuracy of delivery, independent targetability, etc., are not considered by this measure.
- The total value (gross yield) of Soviet SLBMs is based upon our perception of the type and number of observed submarines.

Uncertainties

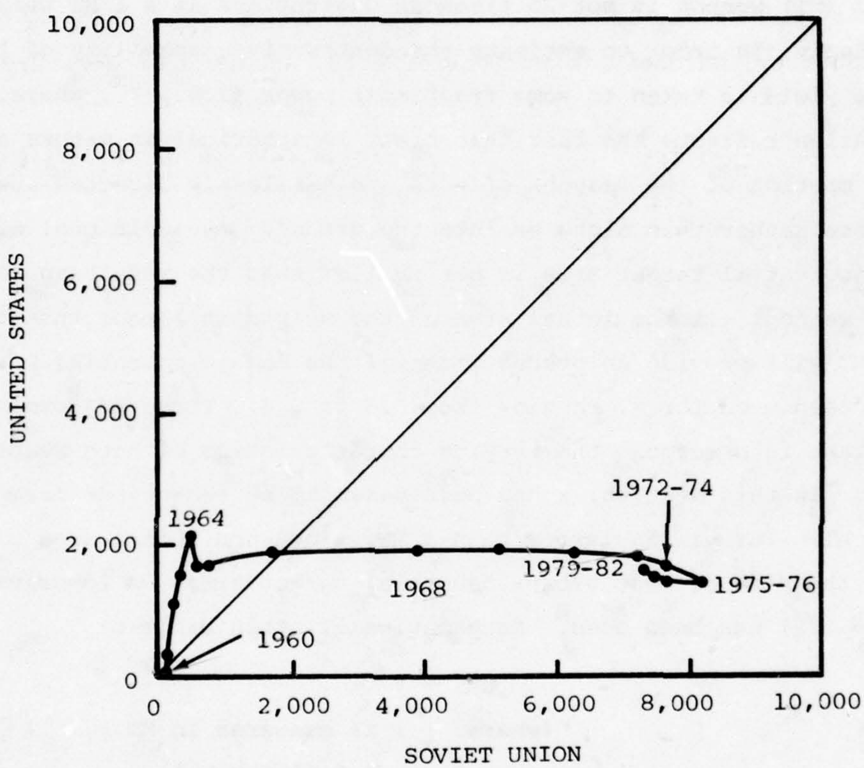
While there is little uncertainty associated with current and past numbers of Soviet SLBM launchers, there is a degree of uncertainty associated with the type and yield of the warheads associated with specific SLBM systems. Since some of the Soviet SLBM systems are deployed in different configurations, there is uncertainty as to the number of MIRVed SLBMs as well as the yield and number of warheads on these missiles.

MEASURE 15

ICBM and SLBM Gross Yield, Inventory

What it Measures

The yield of ICBM and SLBM warheads is totaled.



Limitations

- This measure, being the summation of two previous measures (i.e., ICBM Gross Yield, Inventory and SLBM Gross Yield, Inventory), incorporates all of the limitations of those two measures.

Uncertainties

This measure, being the summation of two previous measures (i.e., ICBM Gross Yield, Inventory and SLBM Gross Yield, Inventory), incorporates all of the uncertainties of those two measures.

SECTION 7: EQUIVALENT MEGATONS

This section compares the Equivalent Megatons (EMT) of the strategic missile forces. EMT is a measure of blast effects against urban-industrial targets. This measure takes into account the fact that weapon destructive power does not grow linearly with an increase in weapon yield. For the same target, a 25 megaton (MT) weapon is not 25 times as destructive as a 1 MT weapon.

Accordingly, in order to estimate the destructive capability of large weapons, the yield is taken to some fractional power (i.e., Y^x, where $x<1$). This formulation reflects the fact that blast is spherical in nature and a significant portion of the weapons effects are harmlessly directed upward into the atmosphere rather than along or into the ground. An additional assumption is that the potential target area is not smaller than the resulting lethal area of the weapon. If the lethal area of the weapon is larger than the target area, EMT will provide an overestimate of the damage potential. Various values have been used for x, ranging from 0.3 to 0.8. These adjustments can be made to take into account the varying characteristics of both weapon types and targets. In this section, x has been taken to be two-thirds for yields less than 1 MT. For yields larger than 1 MT, since the lethal area of a weapon will exceed the size of most urban-industrial target areas, a lower value of x (i.e., x = 1/2) has been used. Mathematically, this becomes:

$$\text{EMT} = Y^x$$

where: Y is measured in MT

and $x = 0.67$ for $Y<1$

$x = 0.5$ for $Y \geq 1$ MT

For example, a 100 KT warhead is valued as 0.22 EMT and a 10 MT warhead is valued as 3.16 EMT by this measure.

Comparisons are made of the EMT of the ICBM forces, the SLBM forces, and the sum of the ICBM and SLBM forces.

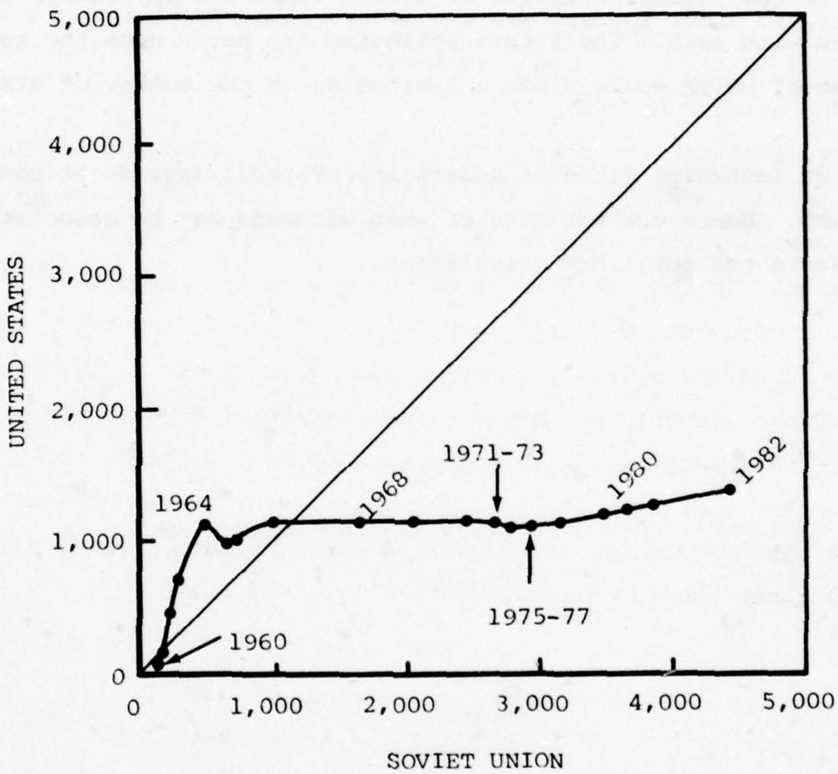
The bomber forces of both nations are not included in this measure because of the various payloads they can carry.

MEASURE 16

ICBM Equivalent Megatons (EMT), Inventory

What it Measures

This measure sums the Equivalent Megatons (EMT) of all the ICBMs in the forces.



Limitations

- EMT is a valid measurement of blast capability against urban-industrial area targets; however, it is not a valid measure against point targets.
- The total values of EMT associated with Soviet ICBMs are based upon our perception of the type and number of Soviet ICBM launchers.
- Totaling up the equivalent megatonnage of ICBM warheads does not take into consideration system or individual reentry vehicle effectiveness. For example, three 200 KT weapons in this measure equate to a single 1 MT weapon. Factors such as prelaunch survivability, reliability,

hardness to nuclear effects, accuracy of delivery, etc., are not considered in this measure.

Uncertainties

There is little uncertainty associated with the current and past numbers of Soviet ICBM launchers. There is, however, a degree of uncertainty associated with the type and yield of the warheads on these missiles. There is also uncertainty as to the future estimates of MIRVed ICBMs and the number of warheads associated with each. The future estimates are based upon the assumption of a SALT agreement which would place a limitation on the number of MIRVed ICBMs.

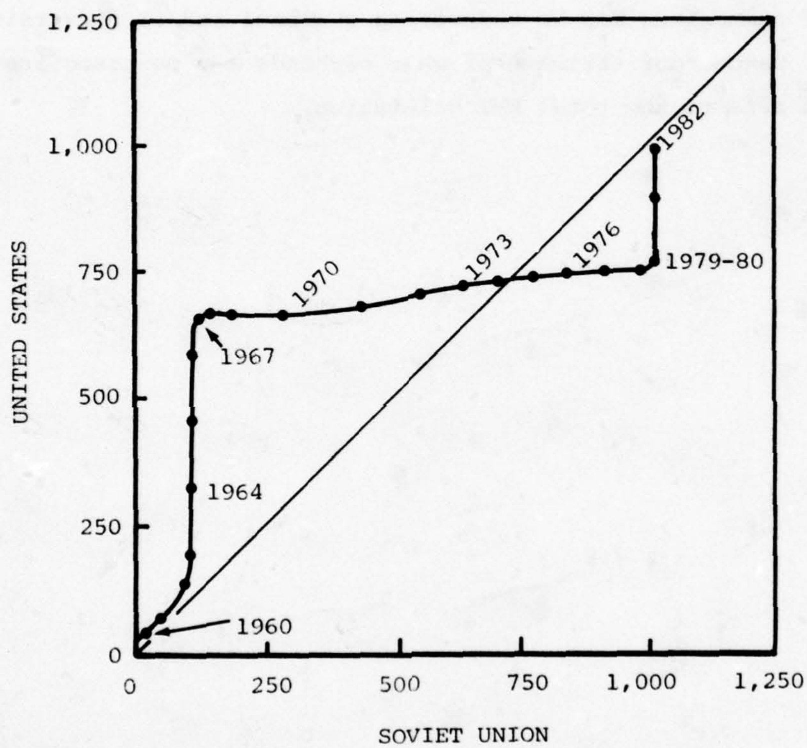
A portion of launching sites is undergoing overhaul/upgrade or conversion at any given time. Hence our estimate of what warheads may be associated with these sites affects the total EMT calculation.

MEASURE 17

SLBM Equivalent Megatons (EMT), Inventory

What it Measures

This measure sums the Equivalent Megatons (EMT) of all the SLBMs in the force.



Limitations

- EMT is a valid measurement of blast capability against urban-industrial area targets; however, it is not a valid measure against point targets.
- The total values of Soviet EMT is based upon our perception of the type and number of SLBM launchers.
- Totaling up the equivalent megatonnage of SLBM warheads does not take into consideration system or individual reentry vehicle effectiveness. For example, three 200 KT weapons, in this measure, equate to a single 1 MT weapon. Factors such as the number of submarines on station, weapon range, reliability, accuracy of delivery, etc., are not considered in this measure.

Uncertainties

The current and past numbers of Soviet SLBM launchers is known with reasonable accuracy. There is also some uncertainty relative to the future estimates of Soviet MIRVed SLBMs and the number of warheads associated with each. Future estimates are based upon the assumption of a SALT agreement which would place a limitation on the number of SLBMs. There is also a degree of uncertainty associated with the type and yield of the warheads on these missiles.

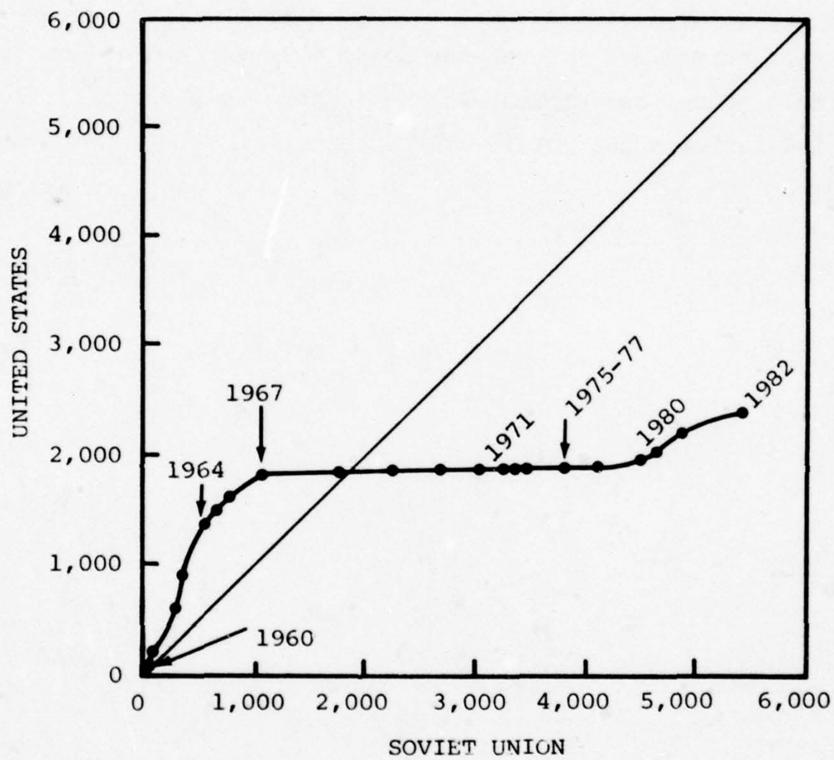
A number of submarines may be undergoing overhaul and/or conversion at any given time. Hence, our estimate of what warheads may be associated with these submarines affects the total EMT calulation.

MEASURE 18

ICBM and SLBM Equivalent Megatons (EMT), Inventory

What it Measures

This measure sums the Equivalent Megatons (EMT) of all the ICBMs and SLBMs in the force.



Limitations

- This measure, being the summation of two other measures (i.e., ICBM EMT, Inventory, and SLBM EMT, Inventory), incorporates all of the limitations of those two measures.
- The measure, by treating warheads the same, has the additional limitation of treating the shorter range, less accurate, SLBM as the equal of the intercontinental range, more accurate ICBMs.

Uncertainties

This measure, being the summation of two other measures (i.e., ICBM EMT, Inventory and SLBM EMT, Inventory), incorporates all of the uncertainties of those two measures.

SECTION 8: BALLISTIC MISSILE DELIVERY ACCURACY

This section compares the delivery accuracy of the two forces. The delivery accuracy of a weapon system is normally measured by the Circular Error Probable (CEP). The CEP is the radius of a circle centered on a target within which half (50%) of the warheads aimed at a target will fall. Expressed differently, it is the radius of a circle centered on a target within which a warhead aimed at the target has a 0.5 probability of falling. An increase in missile delivery accuracy which results in a new CEP equal to one-half of the previous CEP will result in a greater probability of damage to a given target than doubling the yield of the weapon.

For example, a 1 MT weapon with a CEP of 1,500 feet has a single shot damage probability of 0.5 against a 1,000 psi hard target. A [illegible] weapon with the same CEP (1,500 feet) has a single shot damage probability of 0.67 against the same target, whereas a 1 MT weapon with a CEP of 750 feet has a damage probability of 0.92 against that target.

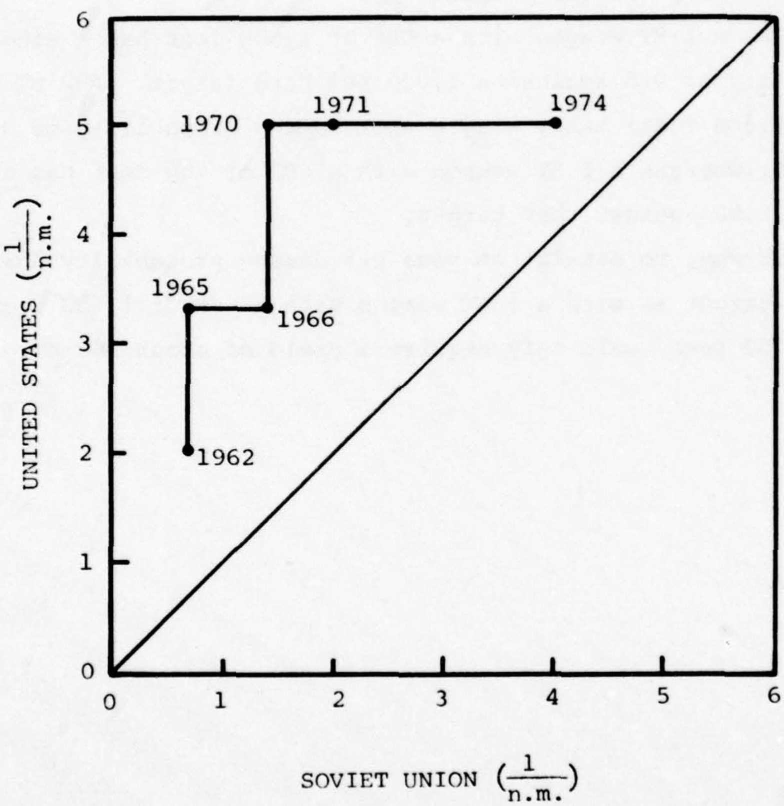
Put another way, to obtain the same 0.5 damage probability against a 1,000 psi hard target as with a 1 MT weapon with a CEP of 1,500 feet, a weapon with a CEP of 750 feet would only require a yield of about 160 KT.

MEASURE 19

Accuracy Comparison (1/CEP) US and USSR ICBMs

What it Measures

The reciprocal of the CEP (i.e., 1/CEP), measured in nautical miles, of the most accurate US ICBM at a given point in time is plotted against the reciprocal of the CEP of the most accurate Soviet ICBM at the same point in time. Therefore, this plot is an analyst's attempt to depict the comparative state of guidance technology.



Limitations

- This measure, in that it displays 1/CEP of only the most accurate ICBM, disregards the accuracy of all other ICBMs in the force at that point in time. Since the most accurate ICBM is often the newest ICBM in the inventory, the curve is sensitive to the introduction of a new weapon system which usually would be a small portion of a nation's ICBM force in the year indicated by the measure.

- The measure disregards all other measures of ICBM force effectiveness such as, prelaunch survivability, warhead yield, MIRV or MRV capability, hardness to nuclear effects, number of missiles, etc.

Uncertainties

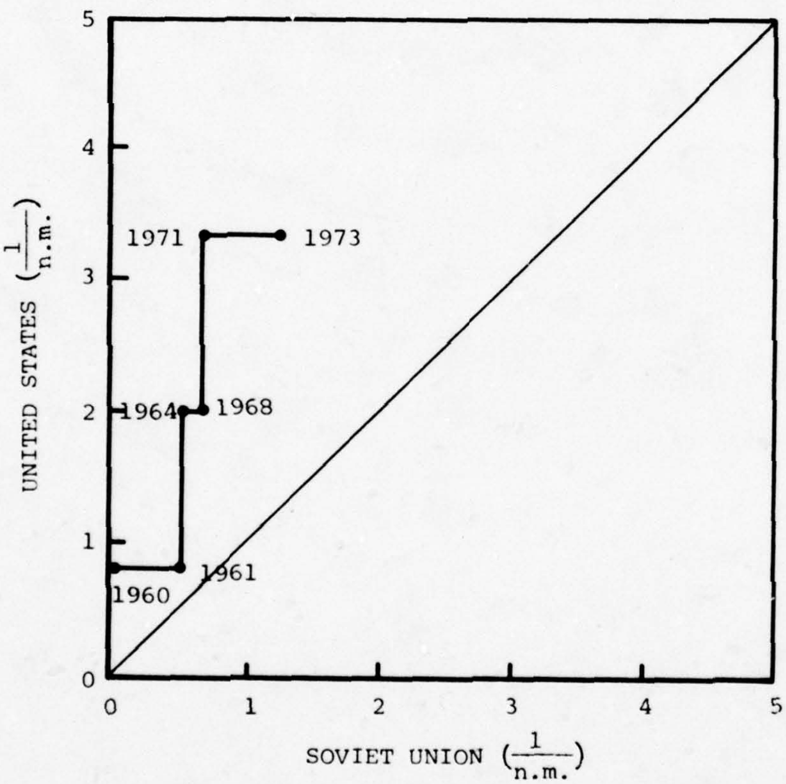
There is a degree of uncertainty associated with the accuracy and year of introduction of past and current Soviet missile systems. Future estimates are based upon a perception of the technological improvements in Soviet missile systems and have a greater degree of uncertainty.

MEASURE 20

Accuracy Comparison (1/CEP) US and USSR SLBMs

What it Measures

The reciprocal of the CEP (i.e., 1/CEP), measured in nautical miles, of the most accurate US SLBM at a point in time is plotted against the reciprocal of the CEP of the most accurate Soviet SLBM at the same point in time. Therefore, this plot is an analyst's attempt to depict the comparative state of guidance technology.



Limitations

- This measure, in that it displays 1/CEP of only the most accurate SLBM, disregards the accuracy of all other SLBMs in the force at that point in time. Since the most accurate SLBM is often the newest SLBM in the inventory, the curve is sensitive to the intro-

duction of a new weapon system which usually would be a small portion of a nation's SLBM force in the year indicated by the measure.

- The measure disregards all other measures of SLBM force effectiveness such as, prelaunch survivability, warhead yield, MIRV or MRV capability, hardness to nuclear effects, number of missiles, number of submarines on station, etc.

Uncertainties

There is a degree of uncertainty associated with the accuracy and year of introduction of past and current Soviet missile systems. Future estimates are based upon a perception of the technological improvements in Soviet missile systems and have a greater degree of uncertainty.

SECTION 9: HARD TARGET KILL CAPABILITY

In this section, the hard target kill capability of the ICBM and SLBM forces is compared.

Hard target kill capability is an aggregate measure employed as an indicator of relative counterforce capabilities. This measure is the result of an attempt to demonstrate the strategic balance in terms of the ability of a force to destroy hardened targets. A homogeneous target set is assumed which is at least as large as the number of warheads available. Target hardness of 1,000; 2,000; and 3,000 psi have been used for this measure. This should not be construed as an indication of either US or USSR target set hardness in that these various hardnesses have been selected to demonstrate the effect of increasing hardness on this measure.

A Vulnerability Number (VN) is used to indicate the relative resistance of a target to damage from blast pressure. The number itself has no physical significance. When assigned to a target, a VN identifies the relation believed to hold between the blast pressure and the probability of damage (of at least the specified degree) for that particular target. High VNs denote targets highly resistant to blast damage; low VNs denote targets with a low resistance to blast damage.

A VN was assigned to each of the three example targets based upon the hardness. Then, for each weapon system available, the Single Shot Probability of Kill (SSP_k) was determined for the three different targets. This SSP_k was multiplied by the number of weapons of each type available each year in order to determine the total number of targets that could be destroyed in that year. Mathematically:

$$C = \text{Capability} = \sum_{i=1}^{\text{ICBM/SLBM}} R_i N_i P_{k_i}$$

where R_i = The reliability of the i^{th} system

N_i = the number of i^{th} independently targetable warheads available

P_{k_i} = The single shot probability of kill for the i^{th} independently targetable warhead.

A combined force reliability rate of 0.85 was assumed in the calculations in this section.

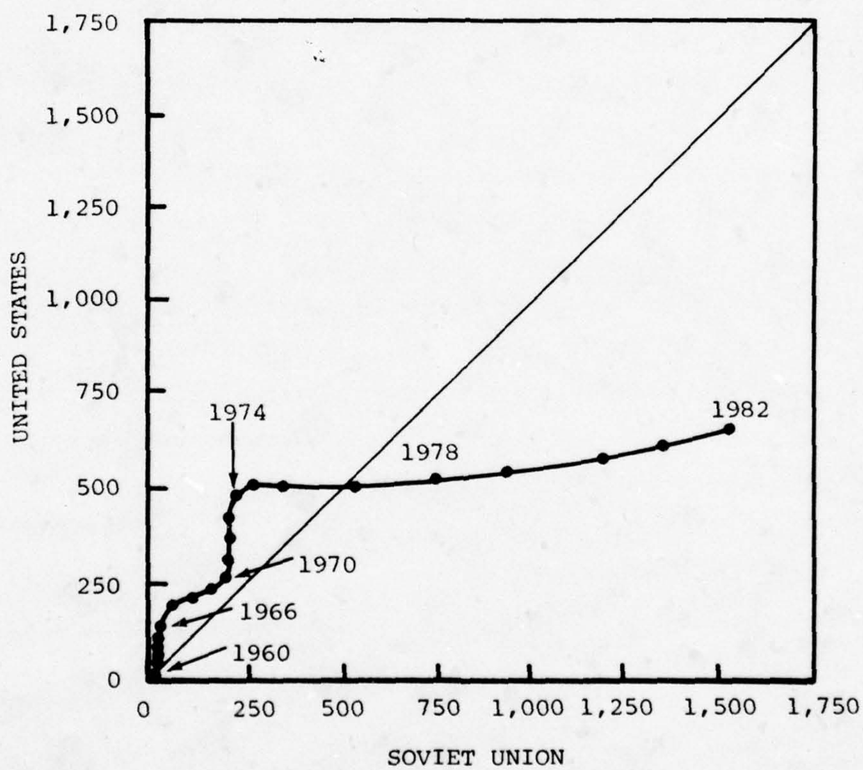
Present SLBMs are not as efficient against hardened targets as are ICBMs. This is primarily because of the large CEPs, although comparatively small weapon yields also contribute to this situation. Measure 21 indicates that the 1977 force of US ICBMs (2,154 RVs) could theoretically kill 507 targets hardened to 1,000 psi, while Measure 25 shows that with the 1977 force of SLBMs (5,120 RVs) only 101 targets hardened to 1,000 psi could be expected to be killed. As a result, SLBMs were not considered in a hard target kill role against 2,000 psi or 3,000 psi hard targets.

MEASURE 21

ICBM Hard Target Kill Capability, 1,000 PSI

What it Measures

This measure compares the hard target kill capability of the two ICBM forces against targets with a hardness of 1,000 psi. A vulnerability number (VN) of 40.9P6 matched the characteristics of the target set. This is equivalent to an adjusted VN of 37.3 (i.e., 1,000 psi) when considering a 1 MT weapon.



Limitations

- This is a general measure designed to illustrate the ability of a force to destroy a homogeneous target set. It is not intended to illustrate the ability of a force to destroy any specific target set.

- The hardness of 1,000 psi was arbitrarily selected, hence the measure cannot necessarily be used as a counterforce index.
- The measure assumes that there is a set of targets available which is at least as large as the number of independently targetable warheads available. This, of course, may or may not be the case.
- The method of calculation was such that relatively ineffective weapons, in some years contributed significantly to the number of targets destroyed.
- The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, ICBM launch, in-flight, and warhead reliabilities vary in actual practice. Also, not included in this measure is a consideration of possible fratricide or the synergistic effects of warheads being used against nearby targets.

Uncertainties

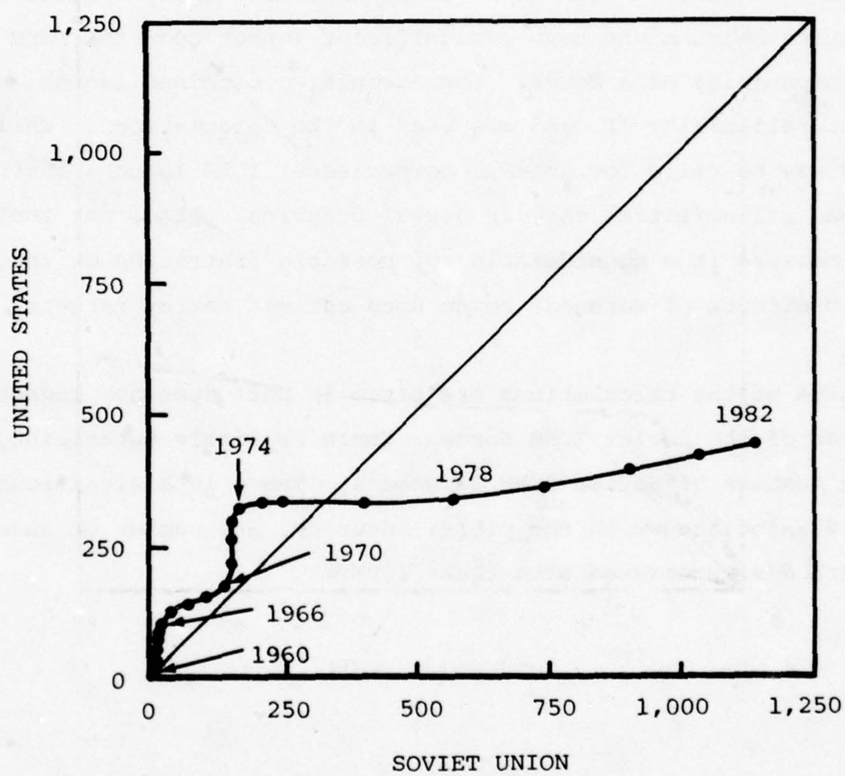
The results of the calculations are based in part upon our conception of the composition of the Soviet ICBM force. There is little uncertainty associated with the numbers of Soviet ICBM launchers. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these ICBMs.

MEASURE 22

ICBM Hard Target Kill Capability, 2,000 PSI

What it Measures

This measure is the same as the preceding measure except that a homogeneous target set of 2,000 psi was considered (i.e., a VN of 45.2P6 or a VN of 41.6 adjusted to a 1 MT weapon was used in this measure).



Limitations

- This measure has the same limitations as the preceding measure (ICBM Hard Target Kill Capability, 1,000 PSI).

Uncertainties

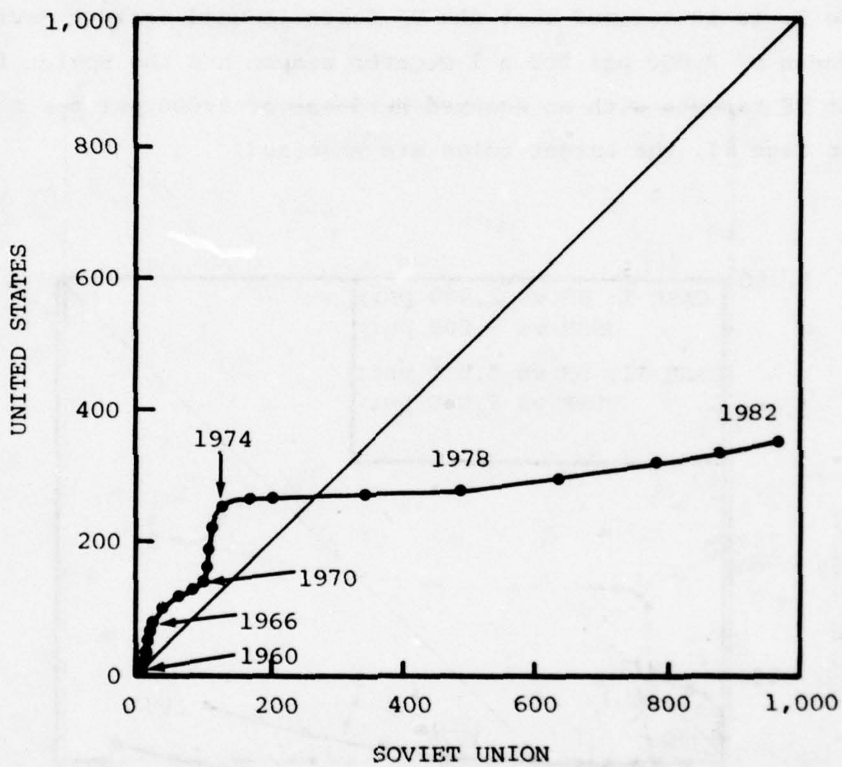
This measure has the same uncertainties as the preceding measure (ICBM Hard Target Kill Capability, 1,000 PSI).

MEASURE 23

ICBM Hard Target Kill Capability, 3,000 PSI

What it Measures

This measure is the same as the two preceding measures except that a homogeneous target set of 3,000 psi was considered (i.e., a VN of 46.9P6 or a VN of 43.3 adjusted to a 1 MT weapon was used in this measure).



Limitations

- This measure has the same limitations as the two preceding measures (ICBM Hard Target Kill Capability, 1,000 PSI and ICBM Hard Target Kill Capability, 2,000 PSI).

Uncertainties

This measure has the same uncertainties as the two preceding measures (ICBM Hard Target Kill Capability, 1,000 PSI and ICBM Hard Target Kill Capability, 2,000 PSI).

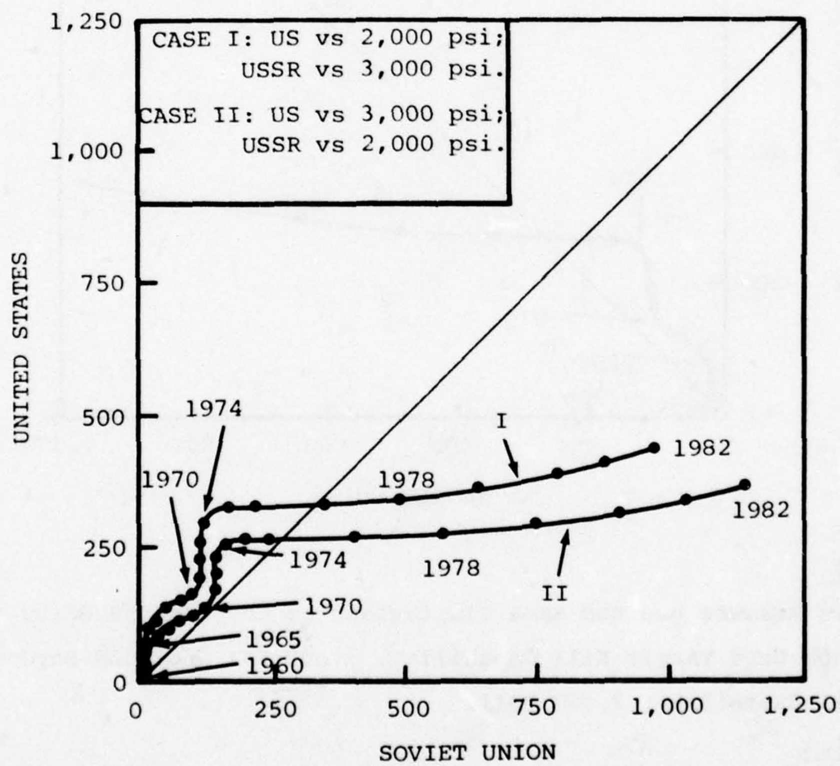
MEASURE 24

ICBM Hard Target Kill Capability, 2,000/3,000 PSI

What it Measures

For this measure, the same general method of calculation is used as in the two preceding measures (i.e., ICBM Hard Target Kill Capability, 2,000 PSI and ICBM Hard Target Kill Capability, 3,000 PSI). However, in this case the calculations are done with differing target hardness for each force.

In Case I, it is assumed that the US force is used against Soviet targets with a hardness of 2,000 psi for a 1 megaton weapon and the Soviet force is used against US targets with an assumed hardness of 3,000 psi for a 1 megaton weapon. For Case II, the target roles are reversed.



Limitations

- The measure has the same limitations as the preceding two measures (ICBM Hard Target Kill Capability, 2,000 PSI, and ICBM Hard Target Kill Capability, 3,000 PSI).

Uncertainties

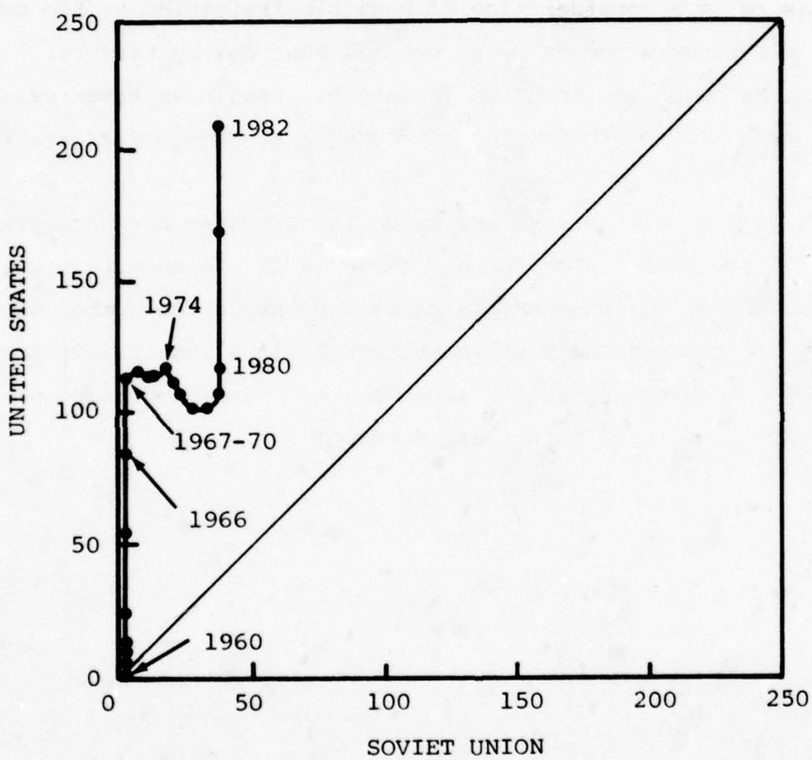
This measure has the same uncertainties as the preceding two measures (ICBM Hard Target Kill Capability, 2,000 PSI, and ICBM Hard Target Kill Capability, 3,000 PSI).

MEASURE 25

SLBM Hard Target Kill Capability, 1,000 PSI

What it Measures

This measure compares the hard target kill capability of the two SLBM forces against targets with a hardness of 1,000 psi. A vulnerability number (VN) of 40.9P6 matched the characteristics of the target set. This is equivalent to an adjusted VN of 37.3 (i.e., 1,000 psi) when considering a 1 MT weapon.



Limitations

- This is a general measure designed to illustrate the ability of a force to destroy a homogeneous target set. It is not intended to illustrate the ability of a force to destroy any specific target set.
- The hardness of 1,000 psi was arbitrarily selected, hence the measure cannot necessarily be used as a counterforce index.
- The measure assumes that there is a set of targets available which is at least as large as the number of independently targetable warheads available. This, of course, may or may not be the case.

- The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, SLBM launch, in-flight, and warhead reliabilities vary in actual practice. Also, not included in this measure is a consideration of possible fratricide or the synergistic effects of warheads being used against nearby targets.
- This measure addresses the SLBM inventory. Readiness rates will significantly affect the number of SLBMs on station and available.

Uncertainties

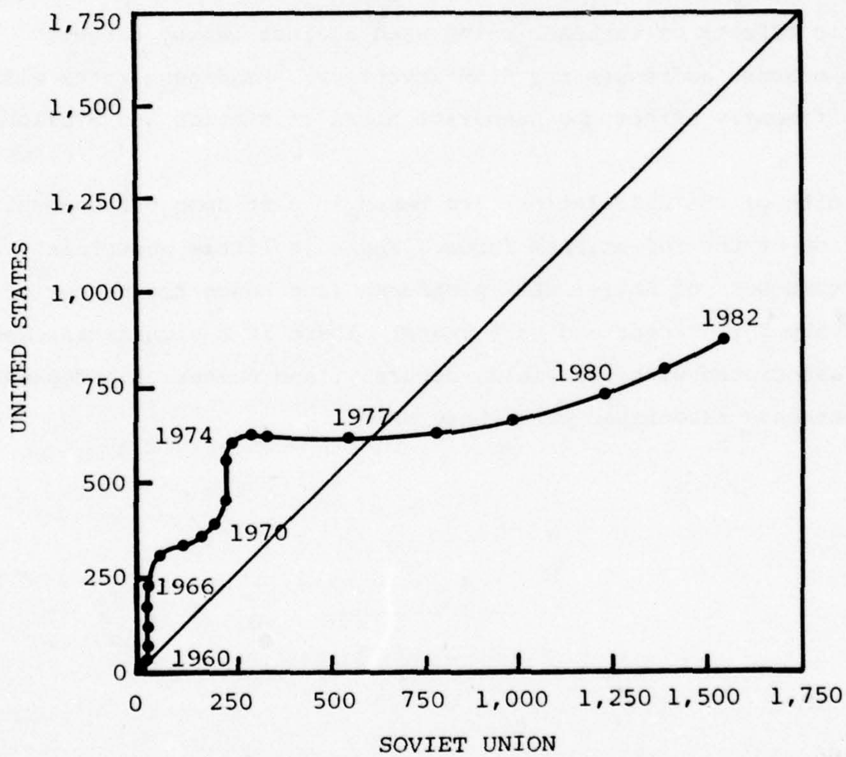
The results of the calculations are based in part upon our conception of the composition of the Soviet SLBM force. There is little uncertainty associated with the numbers of Soviet SLBM platforms (and hence the number of missiles) in the inventory for current and past years. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these SLBMs.

MEASURE 26

ICBM and SLBM Hard Target Kill Capability, 1,000 PSI

What it Measures

This measure is the summation of two previous measures, ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI.



Limitations

- This measure has the same limitations as the two measures it totals (ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI).

Uncertainties

This measure has the same uncertainties as the two measures it totals (ICBM Hard Target Kill Capability, 1,000 PSI and SLBM Hard Target Kill Capability, 1,000 PSI).

SECTION 10: COUNTER MILITARY POTENTIAL

This section compares the Counter Military Potential (CMP) of the US and USSR strategic ballistic missile forces. CMP, also called "lethality," is an aggregate measure devised as an indicator of relative counterforce capabilities. Unlike Equivalent Megatons (EMT) which was devised to aggregate the equivalent yield of each of a number of weapons and, therefore, suggest the total target area which can be covered by a barrage, CMP assumes point target attacks. It is derived by dividing the equivalent yield by the square of any delivery inaccuracy (CEP^2) or aiming error, where CEP (circular error probable) is the radius of a circle around a point target within which half the weapons launched at it can be expected to strike. Mathematically this is expressed as:

$$CMP = \frac{EMT}{(CEP)^2}$$

where: $EMT = Y^{2/3}$; Y is measured in MT

CEP is measured in nautical miles

For example, a 100 KT warhead with a CEP of 0.25 nautical miles is valued as having a CMP of 3.44 and a 5 MT warhead with a CEP of 0.5 nautical miles is valued as having a CMP of 11.7 by this measure.

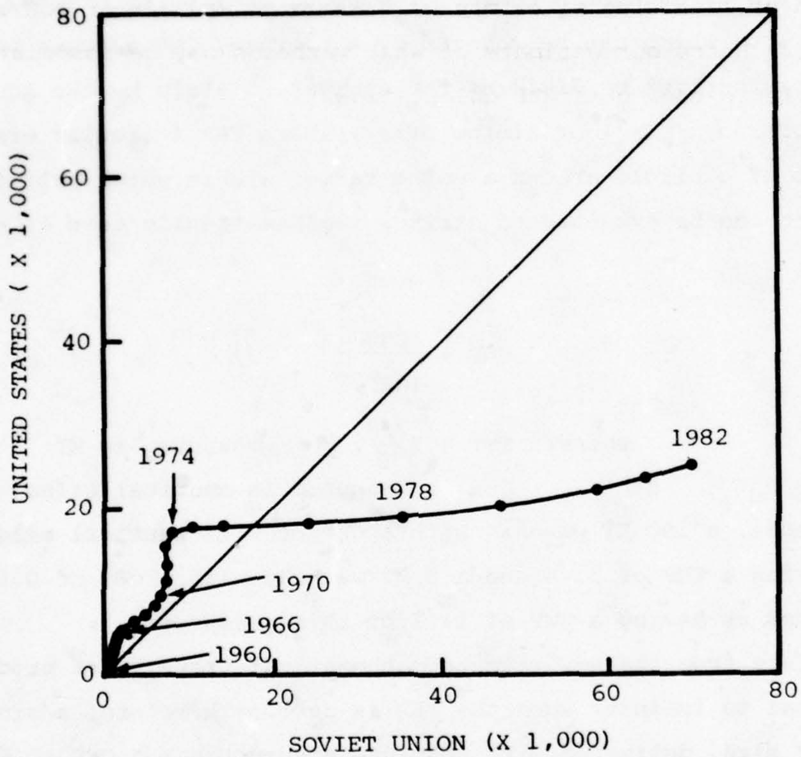
CMP suffers from the unfortunate mathematical property of producing a lethality equal to infinity when the CEP is zero. Therefore, a single weapon of any size, delivered with absolute accuracy has a CMP of infinity and, if added to any stockpile, will raise its index value to infinity without changing damage potential very much, if at all.

MEASURE 27

ICBM Counter Military Potential

What it Measures

This measure is the summation of the Counter Military Potential (CMP) of all the ICBMs in the force.



Limitations

- CMP is a measure intended to estimate a force's capabilities against hard point targets; however, it does not take into account the effects of target hardness.
- The total values of Soviet CMP are based upon our perception of the type and number of ICBM launching sites.
- Totaling up the counter military potential of ICBM warheads does not take into consideration system or individual reentry vehicle effectiveness. Factors such as prelaunch survivability, reliability, hardness to nuclear effects, etc., are not considered in this measure.

Uncertainties

There is little uncertainty associated with the current and past numbers of Soviet ICBM launchers. Future estimates of Soviet ICBM launchers are based upon the assumption of a SALT agreement. There is, however, a degree of uncertainty associated with the type and yield of the warheads on these missiles as well as the accuracy of these systems.

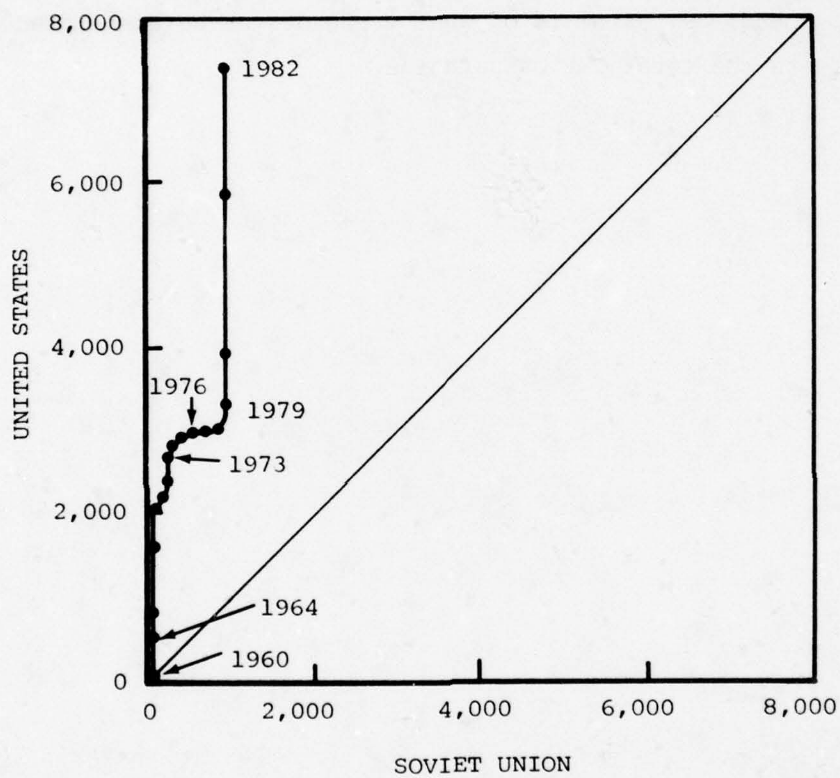
A portion of launching sites may be undergoing upgrade or conversion at any given time. Hence our estimate of what warheads may be associated with these sites affects the total CMP calculation.

MEASURE 28

SLBM Counter Military Potential

What it Measures

This measure is the summation of the Counter Military Potential (CMP) of all the SLBMs in the force.



Limitations

- CMP is a measure intended to estimate a force's capability against hard point targets, however, it does not take into account the effects of target hardness.
- The total values of Soviet CMP are based upon our perception of the type and number of observed submarines.
- Totaling up the counter military potential of SLBM warheads does not take into consideration system or individual reentry vehicle effectiveness. Factors such as prelaunch survivability, reliability, hard-

ness to nuclear effects, submarines on station, weapon range, etc., are not considered in this measure.

Uncertainties

There is little uncertainty associated with the current and past numbers of Soviet SLBM launchers. There is, however, a degree of uncertainty associated with the type and yield of the warheads on these missiles as well as the accuracy of these systems.

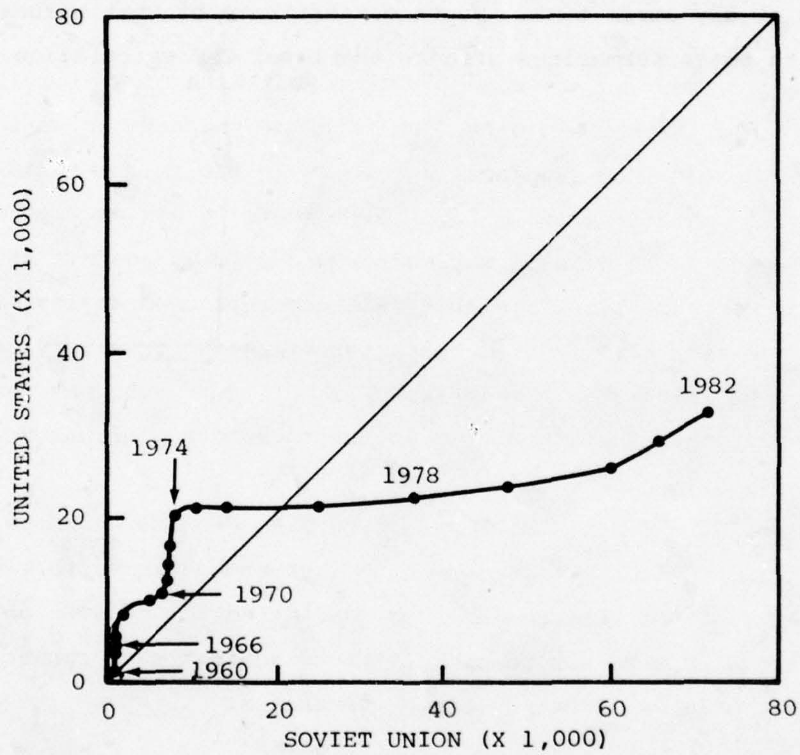
A portion of the total number of submarines is undergoing overhaul and/or conversion at any given time. Hence our estimate of what warheads may be associated with these submarines affects the total CMP calculation.

MEASURE 29

ICBM and SLBM Counter Military Potential (CMP)

What it Measures

This measure simply totals the preceding two measures, namely; ICBM Counter Military Potential and SLBM Counter Military Potential. It is, therefore, the summation of the CMP of all of the ICBMs and SLBMs in the force.



Limitations

- This measure has the same limitations as the preceding two measures (ICBM Counter Military Potential and SLBM Counter Military Potential).

Uncertainties

This measure has the same uncertainties as the preceding two measures (ICBM Counter Military Potential and SLBM Counter Military Potential).

SECTION 11: SURVIVING ICBM LAUNCHERS AFTER A FIRST STRIKE BY EITHER THE US OR USSR

This measure is an attempt to depict the results of an ICBM first strike by either side against the other side's ICBM launchers. Such an exchange is, of course, not possible. However, analysts in an attempt to provide a comparative portrayal of the ability to draw down either the US or Soviet ICBM force have utilized this graphic technique. Computation is accomplished by determining the 50 percent Probability of Damage (P_d) for each ICBM launcher target dependent upon the particular ICBM utilized by the other nation as a weapon. Using this P_d, calculations are made for each year with one nation's ICBM force as the target and the other nation's ICBM force as the attacker attempting to minimize the number of ICBM launchers remaining in the target nation. The two nations' roles are then reversed. For this measure it was assumed that no more than two independently targetable warheads would be used against any ICBM launcher. Two independently targetable warheads were used against an ICBM launcher when the attackers' system characteristics and inventory permitted. A combined launch, in-flight, and strike reliability of 0.85 was used in this measure. When weapon inventory permitted, reprogramming for unsuccessful launches was also used.

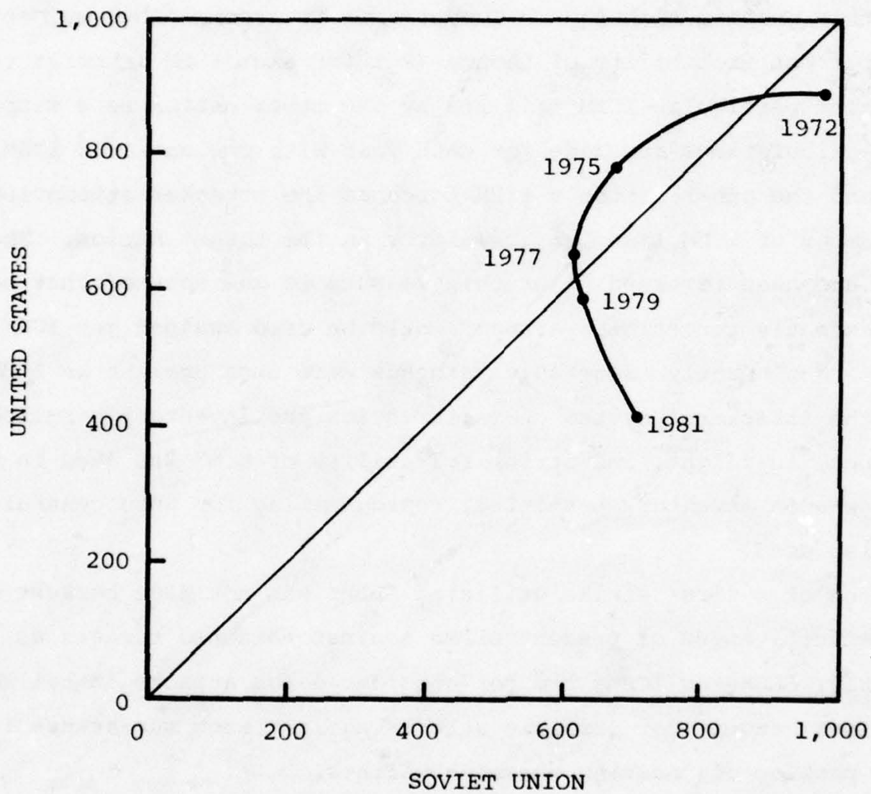
A comparison of a first strike utilizing SLBMs was not made because of the general ineffectiveness of present SLBMs against hardened targets as ICBM silos. Similarly, SLBMs or ICBMs are not considered for attacks on ballistic missile submarines, except for possible attacks against such submarines in port, because of the problem of locating these submarines.

MEASURE 30

Surviving ICBM Launchers After a First Strike by Either the US or USSR

What it Measures

This measure compares the results of an ICBM first strike by either side against the other side's ICBM launchers on a single chart.



Limitations

- To obtain the results in this measure, the number of ICBMs required may exceed the number of weapons which one nation is willing to expend in order to draw down another nation's ICBM force.
- The measure does not depict the number and/or type of weapons that the attacking or attacked nation would have remaining in its inventory after the first strike.

- The measure by simply attempting to maximize the number of ICBM launchers destroyed does not take into account the capabilities of the surviving ICBMs such as yield, EMT, numbers of independently targetable warheads, etc.
- The measure disregards the possibility that the nation attacked may be able to launch out from under attack.

Uncertainties

There is little uncertainty associated with the number of Soviet ICBM launchers. There is a greater degree of uncertainty associated with the yields, numbers of independently targetable warheads, accuracy and reliability of the ICBMs associated with these launchers. There is a significant degree of uncertainty with regard to the hardness of Soviet ICBM launchers and to a lesser degree the hardness of US ICBM launchers.

SECTION 12: RETALIATORY EQUIVALENT WEAPONS

The measures in this section are the result of an analyst's attempt to demonstrate the strategic balance in terms of the ability of a force to retaliate after sustaining a counter-force strike.[1] This section addresses only the ICBM and SLBM second strike effectiveness against a specific enemy target structure.

For each weapon system available, the effectiveness against a generalized target structure is determined. This effectiveness is defined as "equivalent weapons" (EW).

$$\text{EW (per weapon)} = \frac{1}{\frac{a}{P_{k_1}} + \frac{b}{P_{k_2}} + \frac{c}{P_{k_3}}}$$

Where a, b, and c are different types of targets, each expressed as a ratio relative to the total number of targets in the target structure, P_k is the expected probability of kill against that type of target. In this section only three types of targets are considered (a--soft points, b--soft areas, and c--hard points--in these measures 1,000 psi hard). Thus,

$$a + b + c = 1$$

$P_{k_1} = 1$ A soft point target can be killed by any weapon used.

$P_{k_2} = \frac{Y}{Y_0}^{2/3} = Y^{2/3}$ when $Y_0 = 1$ MT, $Y^{2/3}$ gives the P_k (expected value) against the area destroyed by a 1 MT weapon. Therefore, for a soft target, the area of damage due to blast overpressure is proportional to the two-thirds power of a weapon's yield. This results, in this measure, with multi-megaton yield weapons, which are capable of killing larger areas than a 1 MT weapon, being assigned an artificial "P_k" greater than 1. Although it is recognized that a probability cannot exceed 1.

[1] Fred A. Payne, "The Strategic Nuclear Balance: A New Measure," Survival, Volume XX, Number 3, May/June 1977.

P_{k_3} = The single shot probability of kill for an independently targetable warhead against a homogeneous target set with an adjusted vulnerability number (VN) of 37.3 (i.e., 1,000 psi hard) when considering a 1 MT weapon.

To examine the effect the target structure would have on the results, three cases were compared with the target structure ratio varied as follows:

Case I : a = 0.4, b = 0.4, c = 0.2

Case II : a = 0.4, b = 0.2, c = 0.4

Case III : a = 0.2, b = 0.4, c = 0.4

A comparison of the equivalent weapons in the two forces can be made but a more appropriate comparison is the total EW either side could deliver on the other after sustaining a direct or counter-force strike. This total, for ICBMs only, is represented by the following:

$$\text{ICBM Retaliatory EW} = \sum_{i=1}^{\text{ICBM}} N_i EW_i \rho Ps^{\text{BM ATK}} Ps^{\text{ABM}}$$

where N_i = number of i^{th} weapons (independently targetable RVs)

EW_i = equivalent weapons of the i^{th} system

ρ = weapon reliability and other deficiencies

$Ps^{\text{BM ATK}}$ = probability of surviving a ballistic missile attack

Ps^{ABM} = probability of penetrating an anti-ballistic missile attack

The first three measures address reliable ICBM retaliatory equivalent weapons for the three different target structure ratios. In these measures, for illustrative purposes, the results of the previous measure "Surviving ICBM Launchers After a First Strike by Either the US or USSR" were used to determine the number (N_i) of weapons available to either side for a retaliatory strike. Having survived a first strike, the term $Ps^{\text{BM ATK}} = 1$ for these weapons. The EW_i per weapon was calculated as indicated above, with ρ assumed

to be 0.85 and Ps^{ABM} equal to 1. Therefore, under the above assumptions, the calculations of the total reliable ICBM retaliatory EW becomes the summation of the EW (per weapon) times the number of surviving weapons of each type in the force times the reliability. Mathematically:

$$\text{ICBM Retaliatory EW} = \sum_{i=1}^{\text{ICBM}} 0.85\, N_i EW_i$$

where N_i = the number of surviving i^{th} system warheads

EW_i = the equivalent weapons of the i^{th} system

0.85 = the combined force reliability rate assumed in the calculations

The other measures in this section address reliable SLBM retaliatory equivalent weapons and the totals of ICBM and SLBM retaliatory equivalent weapons.

MEASURE 31

Reliable ICBM Retaliatory Equivalent Weapons, Case I

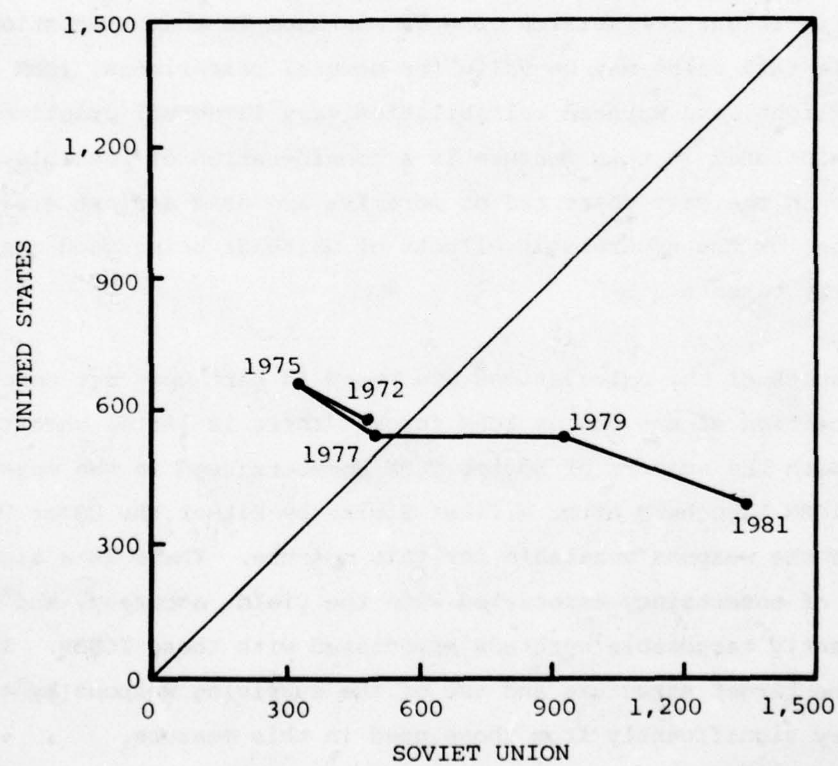
What it Measures

This measure compares US and USSR reliable ICBM retaliatory equivalent weapons against a target structure composed of soft points, soft areas, and 1,000 psi hard points. The ratio of these targets for this case was assumed to be:

a (soft points) = 0.4

b (soft areas) = 0.4

c (1,000 psi hard points) = 0.2



Limitations

- This is a general measure designed to illustrate the ability of a force to retaliate after sustaining a counterforce strike. The available weapons used in the calculations were the result of a previous measure and may or may not represent the actual situation which might exist.

- The measure assumes that there is a set of targets available which is at least as large as the number of retaliatory equivalent weapons available. This, of course, may or may not be the case.
- The measure addresses a total target structure composed of soft points, soft areas, and hard points (1,000 psi) and proportionally aligned in the ratios stated in the examples used. Actual target structure may vary significantly, and, depending upon targeting philosophy, available weapons, and weapon characteristics, so will targets destroyed.
- The measure fails to take into account other weapons systems characteristics which might have a significant impact upon the hard target kill capability of a force. For example, a combined launch and in-flight reliability of 0.85 was used in the calculations. While this value may be valid for general comparisons, ICBM launch, in-flight, and warhead reliabilities vary in actual practice. Also not included in this measure is a consideration of possible fratricide in the case where two or more RVs are used against a single target or the synergistic effects of warheads being used against nearby targets.

Uncertainties

The results of the calculations are based in part upon our conception of the composition of the Soviet ICBM force. There is little uncertainty associated with the numbers of Soviet ICBM boosters used in the measure "Surviving ICBM Launchers After a First Strike by Either the US or USSR" to determine the weapons available for this measure. There is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these ICBMs. In addition, the target structure and use of the surviving weapons by either side may vary significantly from those used in this measure.

MEASURE 32

Reliable ICBM Retaliatory Equivalent Weapons, Case II

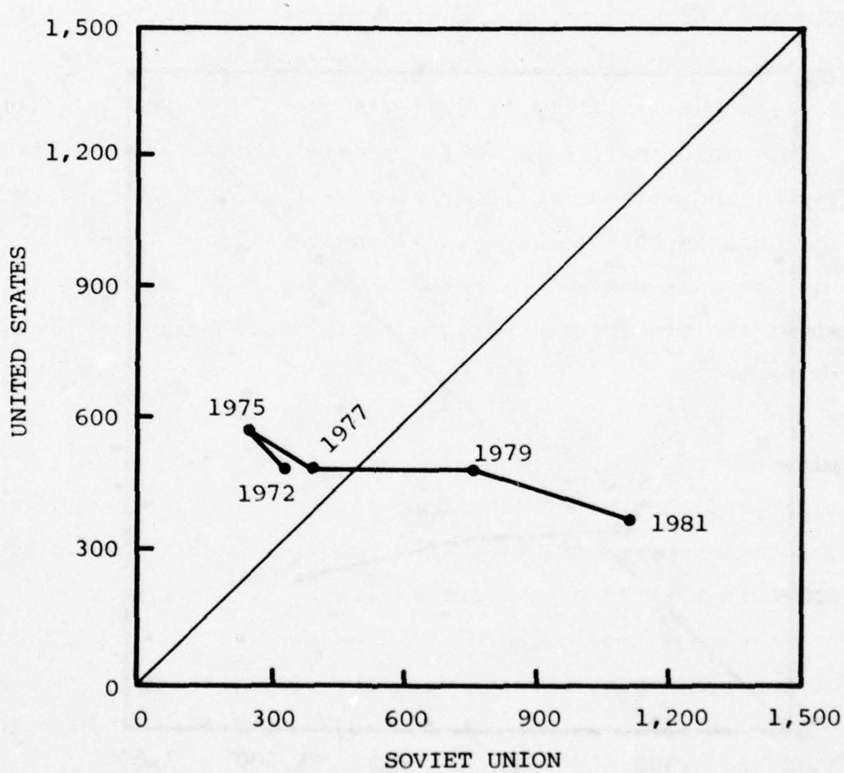
What it Measures

This measure is the same as the preceding measure except that the target ratio has been changed. Specifically:

a (soft points) = 0.4

b (soft areas) = 0.2

c (1,000 psi hard points) = 0.4



Limitations and Uncertainties

The limitations and uncertainties for Case I apply to Case II.

MEASURE 33

Reliable ICBM Retaliatory Equivalent Weapons, Case III

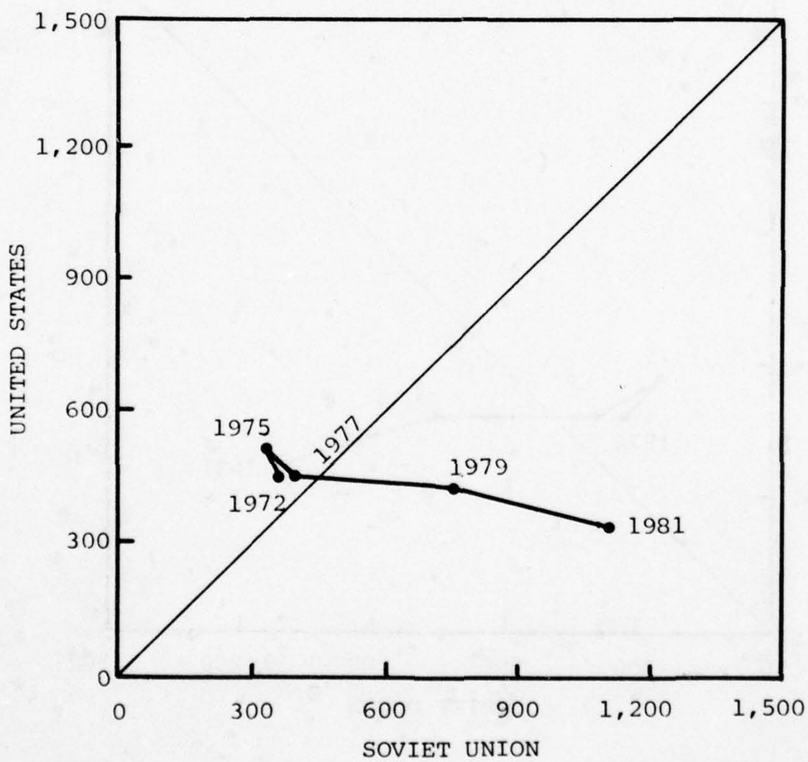
What it Measures

This measure is the same as the preceding two measures except that the target ratio has been changed. Specifically:

a (soft points) = 0.2

b (soft areas) = 0.4

c (1,000 psi hard points) = 0.4



Limitations and Uncertainties

The limitations and uncertainties for Cases I and II also apply here to Case III.

The first part of this section addressed ICBM retaliatory equivalent weapons. The following three measures are the same as the preceding measures except that only SLBMs are addressed. The total reliable SLBM retaliatory equivalent weapons is represented by the following:

$$\text{SLBM Retaliatory EW} = \sum_{j=1}^{\text{SLBM at sea}} N_j EW_j \rho Ps^{ASW} Ps^{ABM}$$

where N_j = number of j^{th} weapons (independently targetable RVs)

EW_j = equivalent weapons of the j^{th} system

ρ = weapon reliability and other deficiencies

Ps^{ASW} = probability of surviving an anti-submarine warfare (ASW) attack

Ps^{ABM} = probability of penetrating an anti-ballistic missile (ABM) system

For the SLBM part of this section, one-half of the ballistic missile submarines (and therefore one-half of the total independently targetable SLBM RVs) were assumed to be on station and available to either side for a retaliatory strike. The EW_j per weapon is calculated as in the previous measure. Ps^{ASW} was assumed to be equal to 1, ρ was assumed to be 0.85, and Ps^{ABM} was assumed to be 1. Therefore, under the above assumptions, the calculations of the total reliable SLBM retaliatory EW becomes one-half of the summation of the EW_j (per weapon) times the number of available weapons of each type in the force times the reliability. Mathematically:

$$\text{SLBM Retaliatory EW} = 0.5 \sum_{j=1}^{\text{SLBM}} 0.85\, N_j EW_j$$

where N_j = the number of j^{th} system warheads

EW_j = the equivalent weapons of the j^{th} system

0.85 = the combined force reliability rate assumed in the calculations

MEASURE 34

Reliable SLBM Retaliatory Equivalent Weapons, Case I

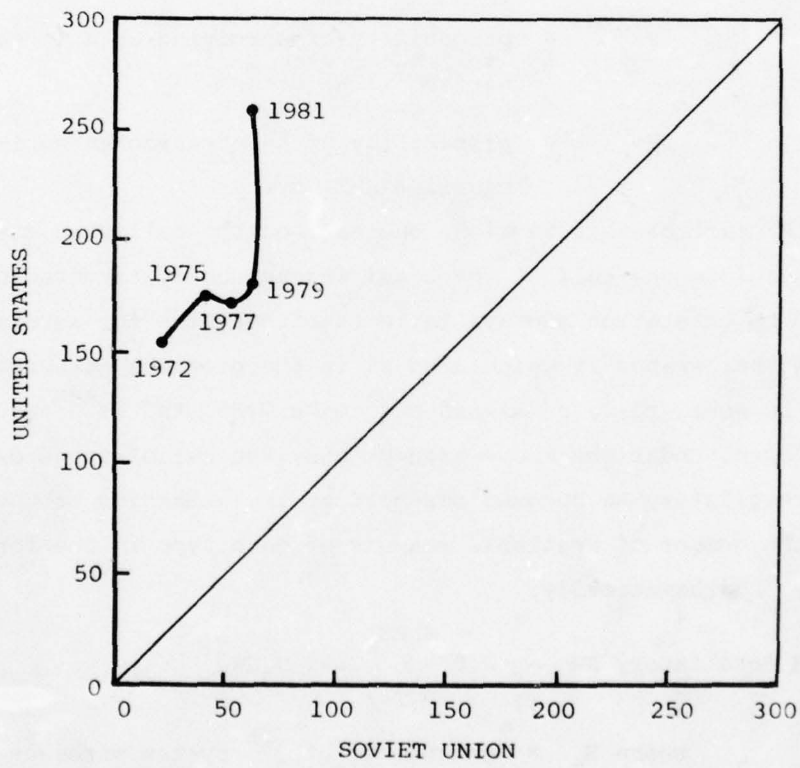
What it Measures

This measure compares US and USSR reliable SLBM retaliatory equivalent weapons using the same Case I target structure assumed for the preceding ICBM comparison. Specifically:

a (soft points) = 0.4

b (soft areas) = 0.4

c (1,000 psi hard points) = 0.2



Limitations

- This measure has the same limitations as the previous Case I ICBM measure (Reliable ICBM Retaliatory Equivalent Weapons, Case I).

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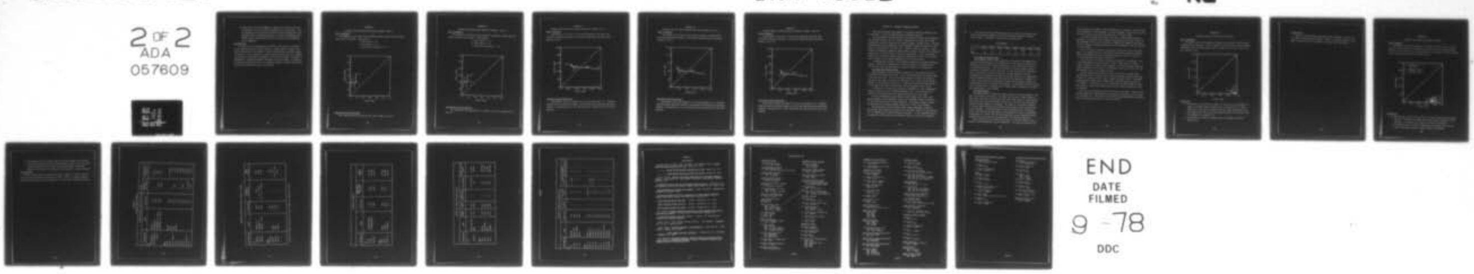

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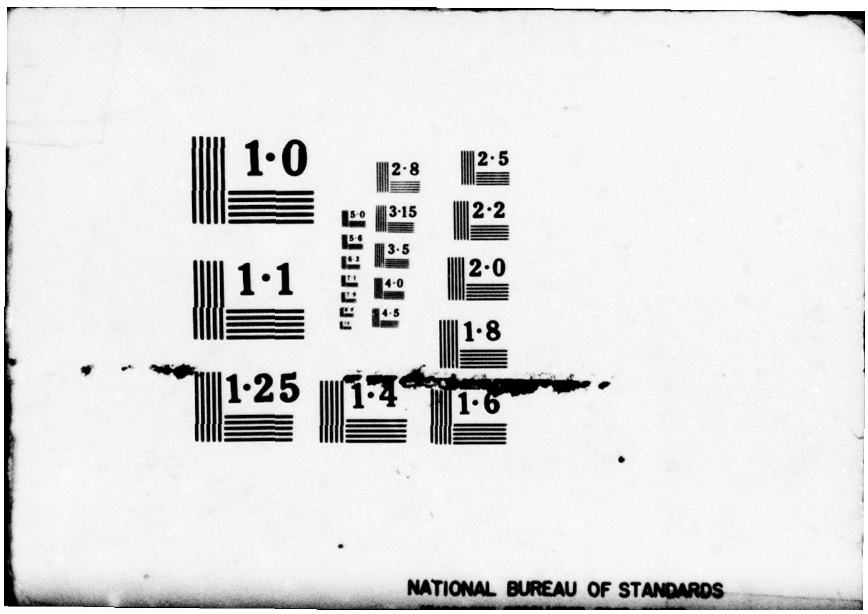
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NATIONAL BUREAU OF STANDARDS

* Additionally, the actual numbers of submarines on station may vary considerably from the 50 percent assumed in the calculations. Plus the probability of surviving an ASW attack may be significantly less depending upon any determined efforts to locate the submarines and destroy them in conjunction with the first strike on the homeland of the submarines.

Uncertainties

The results of the calculations are based in part upon our conception of the composition of the Soviet SLBM force. While there is little uncertainty associated with the number of Soviet SLBM platforms (and hence number of missiles) in the inventory for current and past years, there is a significant degree of uncertainty associated with the yield, accuracy, and number of independently targetable warheads associated with these SLBMs. In addition, the target structure and use of the available weapons by either side may vary significantly from those used in this measure.

MEASURE 35

Reliable SLBM Retaliatory Equivalent Weapons, Case II

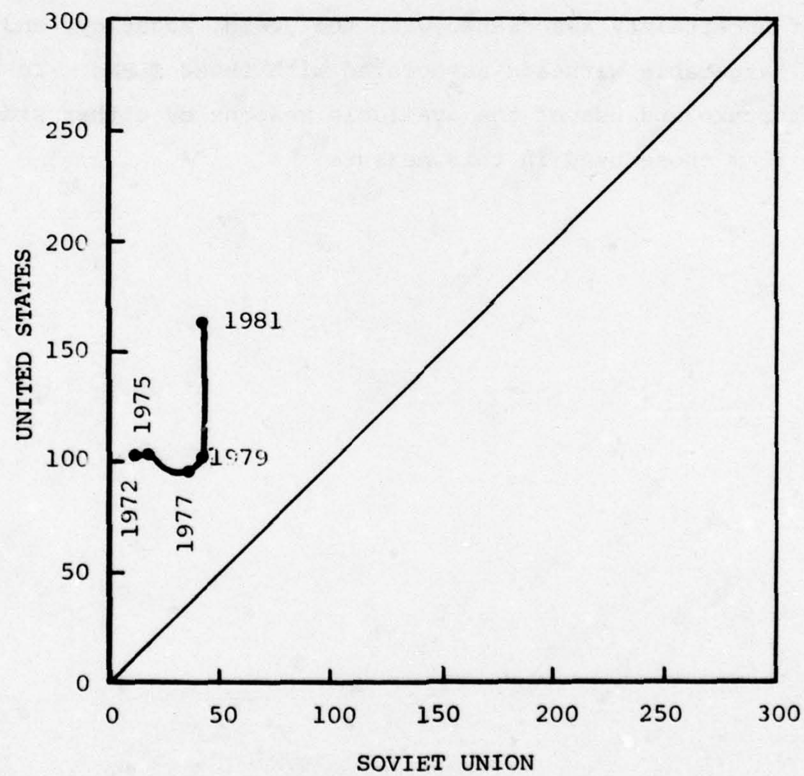
What it Measures

This measure is the same as the preceding measure except that the target ratio has been changed. Specifically:

a (soft points) = 0.4

b (soft areas) = 0.2

c (1,000 psi hard points) = 0.4



Limitations and Uncertainties

The limitations and uncertainties for Case I apply to Case II.

MEASURE 36

Reliable SLBM Retaliatory Equivalent Weapons, Case III

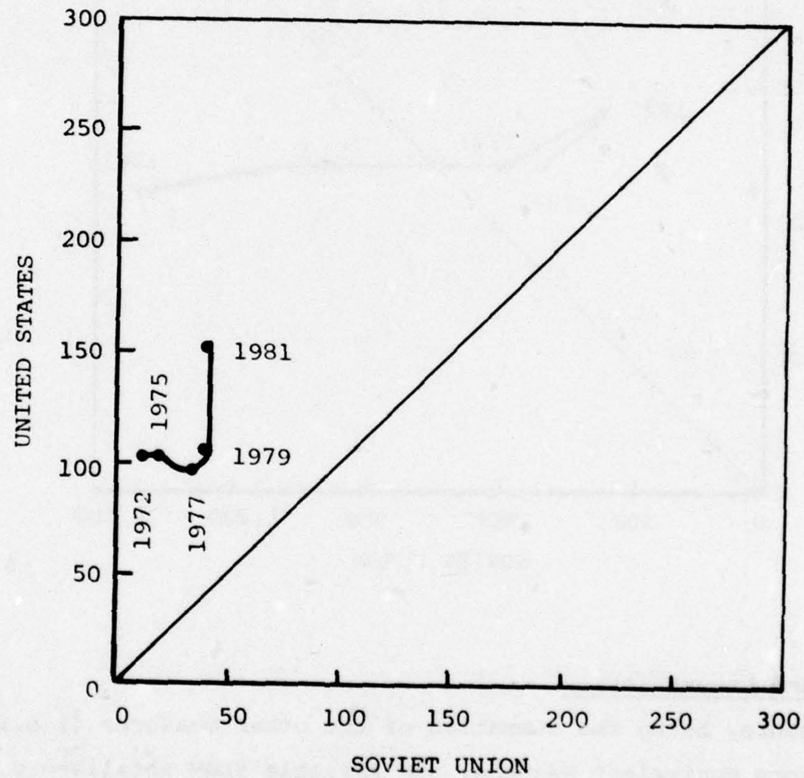
What it Measures

This measure is the same as the preceding two measures except that the target ratio has been changed. Specifically:

a (soft points) = 0.2

b (soft areas) = 0.4

c (1,000 psi hard points) = 0.4



Limitations and Uncertainties

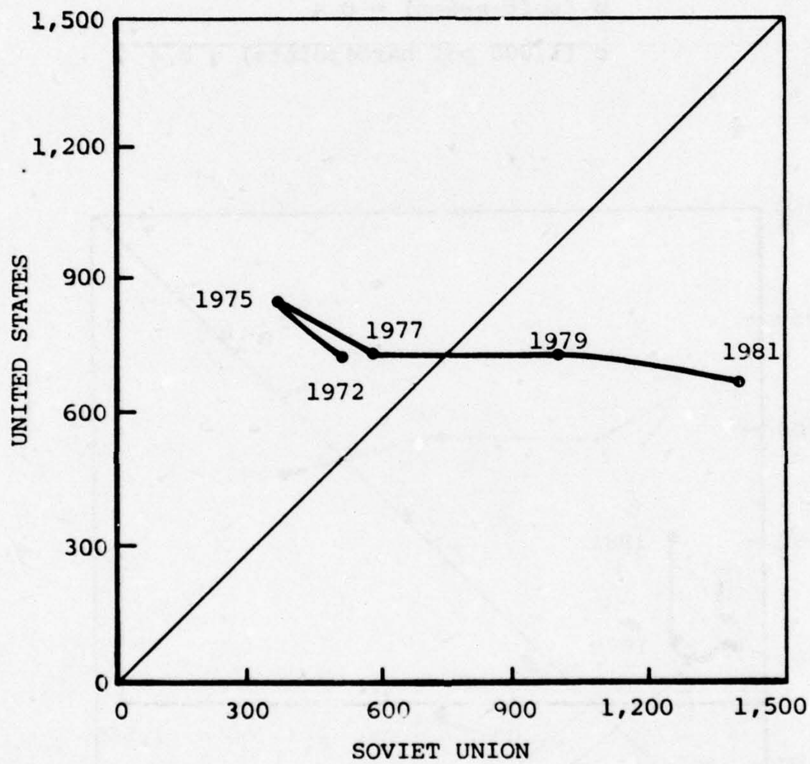
The limitations and uncertainties for Cases I and II also apply here to Case III.

MEASURE 37

Reliable ICBM and SLBM Retaliatory Equivalent Weapons, Case I

What it Measures

This measure is the total of two previous measures (Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent Weapons), Case I.



Limitations and Uncertainties

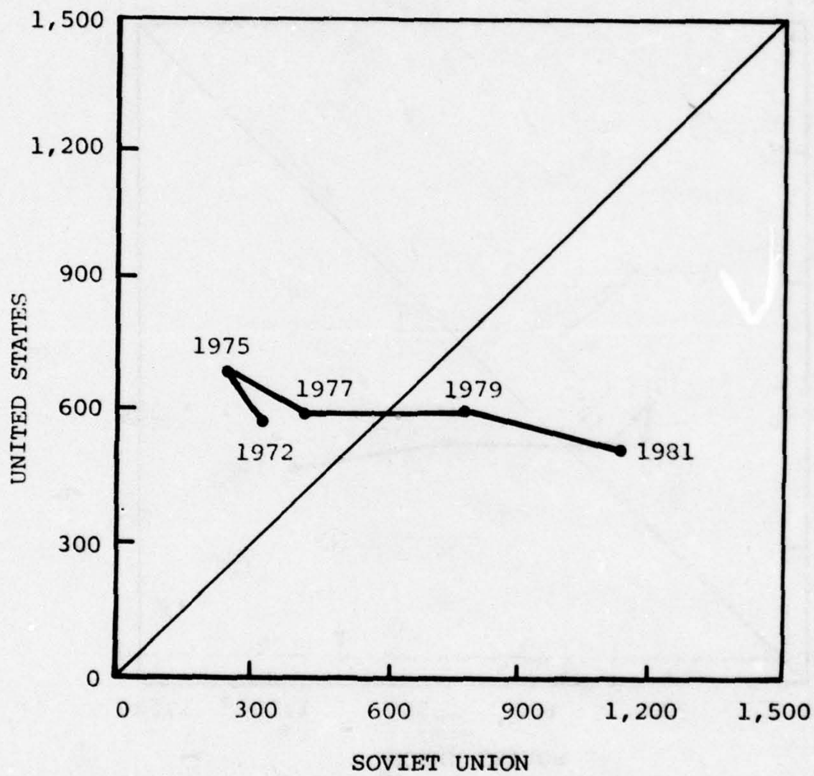
This measure, being the summation of two other measures (i.e., Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent weapons), incorporates all of the limitations and uncertainties of those two measures.

MEASURE 38

Reliable ICBM and SLBM Retaliatory Equivalent Weapons, Case II

What it Measures

This measure is the total of two previous measures (Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent Weapons), Case II.



Limitations and Uncertainties

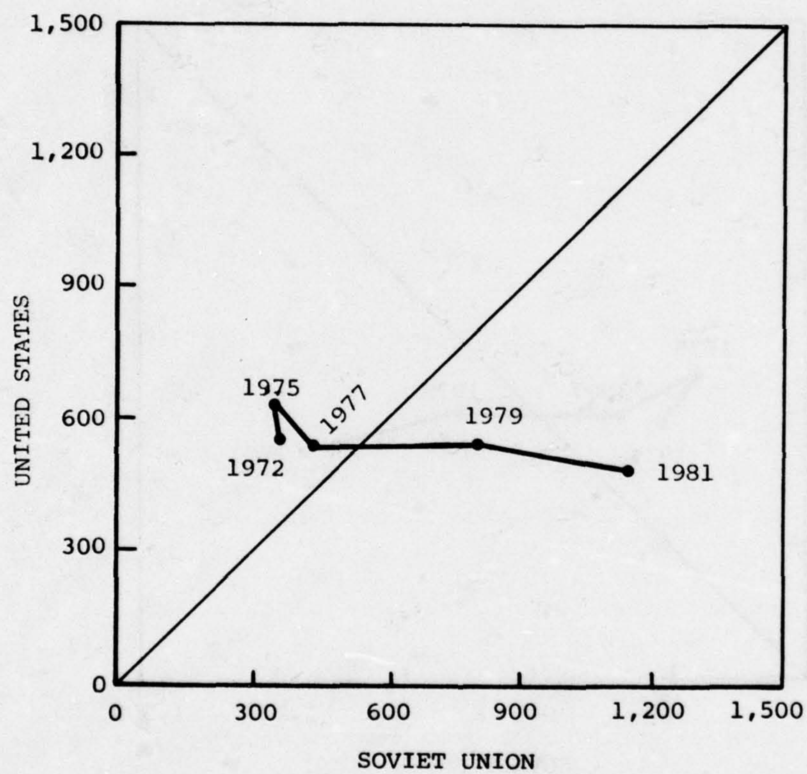
This measure, being the summation of two other measures (i.e., Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent Weapons), incorporates all of the limitations and uncertainties of those two measures.

MEASURE 39

Reliable ICBM and SLBM Retaliatory Equivalent Weapons, Case III

What it Measures

This measure is the total of two previous measures (Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent Weapons), Case III.



Limitations and Uncertainties

This measure, being the summation of two other measures (i.e., Reliable ICBM Retaliatory Equivalent Weapons, and Reliable SLBM Retaliatory Equivalent Weapons), incorporates all of the limitations and uncertainties of those two measures.

SECTION 13: STRATEGIC DEFENSIVE SYSTEMS

This section compares the numbers of strategic defensive weapons of the US and USSR. It does not address passive defensive measures.

The relationships between offensive and defensive systems, when addressing the strategic balance, are not linear. Defenses may be active and include interceptor aircraft, Surface-to-Air Missiles (SAMs), and ASW forces. They may be passive and include dispersal of the targetable resources, population sheltering, and hardening of specific sites. Whether active or passive, a small increase in defensive capability might require a major increase in the offensive capability of the other nation to maintain the balance. On the other hand, a large effort to improve defenses might be required as a result of a relatively small increase in the offensive capability of the other nation.

A comprehensive analysis of the strategic balance must consider defensive systems. While these systems cannot directly threaten the homeland of the other nation, they can contribute to strategic stability or instability.

Anti-Ballistic Missile Forces

The Anti-Ballistic Missile (ABM) systems of the two countries are constrained by the ABM Treaty of 1972. This treaty limited both the US and USSR to two ABM sites each. One site could be located to protect the national capital and the other to protect an ICBM launch area. Each site was further limited to 100 launchers and missiles. Additional restrictions were placed on the number and types of radars which could be employed at the sites.

A Protocol to the ABM Treaty ratified on November 10, 1975, subsequently limits the parties to only one ABM deployment site. This site may be relocated on a one-time basis with advance notice given of the change.

The Soviet ABM defenses are centered around Moscow and include early warning radars, battle management radars, and engagement radars in addition to four interceptor missile launch complexes. Each launch complex contains 16 launchers for the ABM-1B GALOSH missile for a total of 64 launchers.

The US Ballistic Missile Defense (BMD) system, SAFEGUARD, located at Grand Forks, North Dakota, consisted of the necessary radars and 100 launchers for 30 SPARTAN and 70 SPRINT interceptor missiles. It was terminated and inactivated at the direction of the Congress after only one year of operation.

The relative number of ABM launchers does not present a meaningful graph to show the trends in numbers of the defensive system available to either nation; rather, a comparison is made in the following table.

ABM LAUNCHERS

	1970	1971	1972	1973	1974	1975	1976	1977
US	0	0	0	0	0	100	0	0
USSR	64	64	64	64	64	64	64	64

Anti-Submarine Warfare Forces

Anti-Submarine Warfare (ASW) capabilities are important considerations in assessing the effectiveness of the SLBM forces. Both the US and USSR are confronted with the fact that nearly three-fourths of the surface of the earth is covered by the oceans. The total land area of the US and USSR is equal to only about ten percent of this ocean area. If only ten percent of the ocean area is available and useful for ballistic missile submarines (the area determined by such things as the range of the SLBMs carried by the submarines), then the problem of detection and tracking even 100 submarines is immense. As a result, both nations have substantial research and development programs directed towards solving the various ASW problems. The complexities of the problem and the various types of resources used in ASW preclude a comparison of US and USSR capabilities in this document.

Air Defense Forces

The most extensive strategic air defense system in the world belongs to the USSR. Consisting of more than 12,000 Surface-to-Air Missile (SAM) launchers, about 2,600 interceptor aircraft, and over 6,000 radars located at early warning and ground control intercept (EW/GCI) radar sites, this force was generated to counter the large numbers of US bombers. The number of interceptors assigned to the PVO Strany (the Soviet Air Defense Force) reached a peak of about 4,000 in the mid-1960s. It has decreased at a slow but steady rate to the present 2,600. This decrease has been caused by the retirement of older, clearweather-only fighters at a faster rate than the introduction of more advanced aircraft armed with air-to-air missiles and possessing an all-weather capability.

About one-third of the present force consists of pre-1964 aircraft (MIG-17 FRESCO-D, MIG-19 FARMER-B/E, and SU-9 FISHPOT-B). The remaining two-thirds are

newer generation interceptors (YAK-28P FIREBAR, SU-11 FISHPOT-C, TU-128 FIDDLER, SU-15 FLAGON-A/D/E, MIG-25 FOXBAT-A, and MIG-23 FLOGGER), with the MIG-23, SU-15, and MIG-25 fighters presently being deployed to PVO Strany units.

The Soviet strategic SAM forces, which show a steady expansion and improvement, is composed of four systems. These systems are the SA-1 GUILD, the SA-2 GUIDELINE, the SA-3 GOA, and the SA-5 GAMMON. The numbers of older SA-1 and SA-2 systems are gradually decreasing as the deployment of the SA-3 and SA-5 systems increases.

The US air defense system is considerably smaller than that of the USSR. Some of this difference can be attributed to the Soviet reliance on ICBM and SLBM nuclear weapons delivery vice manned bombers and some of it due to decisions based upon tight budget constraints.

The only active US Air Force interceptor dedicated to air defense is the F-106 DELTA DART which entered service in 1956. There are 114 of these fighters assigned to regular active squadrons. The US Air National Guard provides an additional 243 aircraft to air defense; these are 90 F-106, 19 F-102 DELTA DAGGER, and 134 F-101 VOODOO aircraft.

General purpose forces from the Air Force Tactical Air Command (TAC), and from Army, Navy, and Marine forces which have primary missions other than strategic air defense would be used to augment the above forces. The primary general purpose fighter used to augment the interceptor force would be the F-4 PHANTOM II. Additionally, as F-14 TOMCAT and F-15 EAGLE fighters become more numerous, these highly sophisticated and most capable aircraft will also be available.

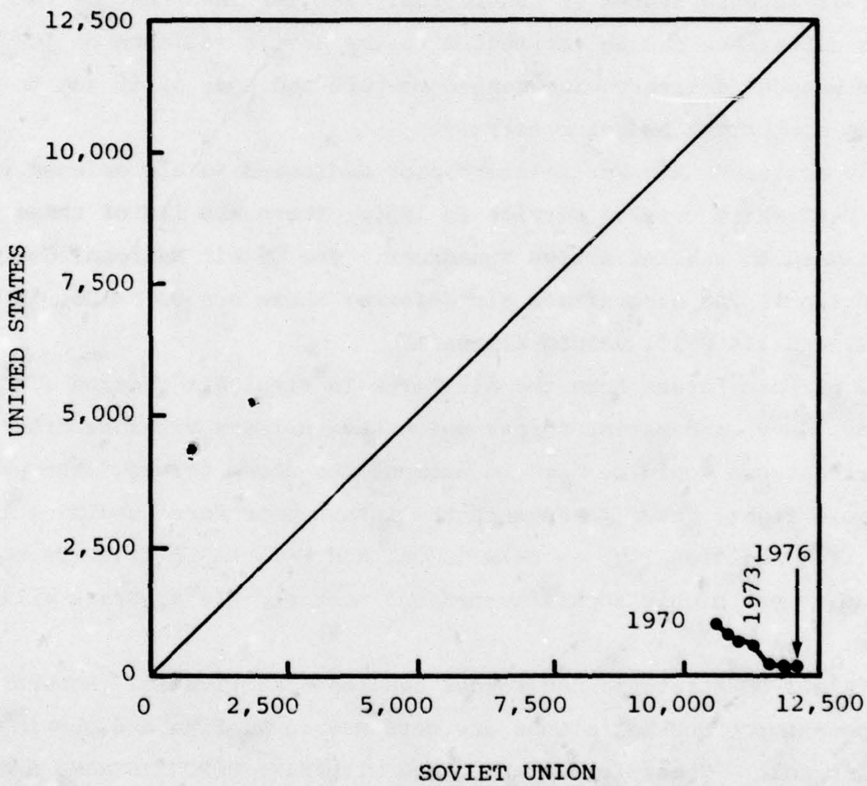
By 1975, all US strategic SAM forces had been inactivated. However, three general purpose force SAM battalions are retained in Florida and one in Alaska in a strategic role. These forces are armed with NIKE HERCULES SAMs and complement the interceptor aircraft in these two locations.

MEASURE 40

Strategic Surface-to-Air Missile Launchers

What it Measures

This measure totals the number of strategic Surface-to-Air Missile (SAM) system launcher arms/rails. The US figures are for the number of NIKE HERCULES and BOMARC, while the USSR figures total the number of SA-1, SA-2, SA-3, and SA-5 launcher rails.



Limitations

- This measure, by totaling the number of launcher rails disregards the number of systems actually available for a defensive role. Either positioning (location) or system status may negate any defensive use.
- This measure does not include SAM characteristics such as range, altitude capability, guidance, etc.
- This measure, by counting launcher rails, disregards any reload capabilities.

Uncertainties

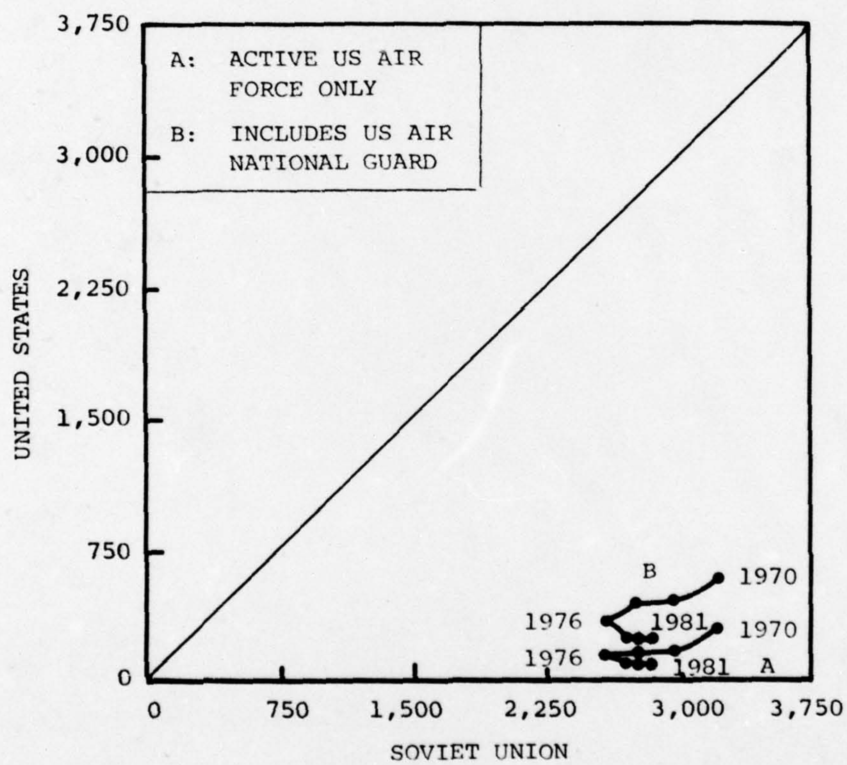
There is some uncertainty associated with the number of current and past numbers of Soviet SAM launchers. There is a greater degree of uncertainty associated with our perception of future Soviet SAM forces.

MEASURE 41

Strategic Air Defense Interceptor Aircraft

What it Measures

The number of aircraft assigned to a strategic defensive role is totaled. The active US Air Force and the combined US Air Force and Air National Guard forces are both depicted. The Soviet aircraft are interceptor aircraft assigned to the PVO Strany (the Soviet Air Defense Force).



Limitations

- This measure, by counting the number of strategic defensive interceptor aircraft, disregards the number of aircraft actually available to fly missions. It also does not consider aircraft base locations.
- This measure does not include interceptor force capabilities such as range, fire-control systems, weapons, speed, and altitude.

- This measure does not include similar aircraft assigned to US tactical and naval units and the Soviet Frontal Aviation units. Both the United States and the Soviet Union have a significant number of aircraft capable of fulfilling an interceptor role assigned to tactical missions.

Uncertainties

There is some uncertainty associated with the number of current and past Soviet strategic defensive interceptor aircraft. There is a greater degree of uncertainty associated with our perception of future Soviet interceptor forces.

APPENDIX A

PRESENT WEAPON SYSTEMS

INTERCONTINENTAL BALLISTIC MISSILES (ICBMs)				
DESIGNATION	NAME	OPERATIONAL	WARHEADS PER MISSILE	THROW-WEIGHT (pounds)
US				
SM-68/LGM-25	TITAN II	1963	1	8,000
SM-80/LGM-30F	MINUTEMAN II	1966	1	2,500
LGM-30G	MINUTEMAN III (MK12)	1970	3 MIRV	2,500
	MINUTEMAN III (MK12A)	1978	3 MIRV	2,500
USSR				
SS-9	SCARP	1966	1	12-15,000
SS-11	SEGO	1966	1	2,000
SS-11 (MOD 3)	SEGO	1973	3 MRV	2,000
SS-13	SAVAGE	1969	1	2,000
SS-16		1978	1	2,000
SS-17		1975	4 MIRV	5,000
SS-18		1974	1	15,000
SS-18 MOD II		1976	8-10 MIRV	15,000
SS-19		1975	6 MIRV	7,000

SUBMARINE-LAUNCHED BALLISTIC MISSILES (SLBMs)

DESIGNATION	NAME	OPERATIONAL	WARHEADS PER MISSILE	RANGE (n.miles)
<u>US</u>				
UGM-27C	POLARIS A-3	1964	3 MRV	2,500
UGM-73A	POSEIDON C-3	1971	up to 14 MIRV	2,500
UGM-93A	TRIDENT I (C-4)	1980	est. up to 24 MIRV	4,000
<u>USSR</u>				
*SS-N-4		1958	1	350
SS-N-5	SARK	1963	1	650+
SS-N-6	SERB	1968	1	1,300 - 1,600
SS-N-8	SAWFLY	1973	1	4,200

*SS-N-4 is surface launched; all other SLBMs are underwater launch.

STRATEGIC BOMBERS				
DESIGNATION	NAME	OPERATIONAL	UNREFUELED COMBAT RANGE (n.miles)	MAXIMUM SPEED
<u>US</u>				
B-52G	STRATOFORTRESS	1959	6,500	645 mph
B-52H	STRATOFORTRESS	1959	8,700	645 mph
FB-111A	--	1969	3,500	Mach 2.5
<u>USSR</u>				
TU-95	BEAR	1956	7,800	550 mph
MYA-4	BISON	1956	6,300	620 mph
TU-26 (?)	BACKFIRE	1973	--	Mach 2+

DEFENSIVE SURFACE-TO-AIR MISSILES

DESIGNATION	NAME	OPERA-TIONAL	LAUNCH SITE	NUMBER OF RAILS, ARMS	TYPE WARHEAD	COMBAT CEILING (feet)
<u>US</u>						
	NIKE-HERCULES	1958	Fixed	1	HE, Nuclear	Lo-Med
MIM-23A	HAWK	1960	Mobile	3	HE	100,000
<u>USSR</u>						
SA-1	GUILD	1956	Fixed	1	HE	Med-High
SA-2	GUIDELINE	1958	Fixed	1	HE	70,000
SA-3	GOA	1961	Fixed	2,4	HE	Lo-Med
SA-5	GAMMON	1963	Fixed	1	HE	Med-High

STRATEGIC DEFENSIVE INTERCEPTORS							
DESIGNATION	NAME	OPERATIONAL	NO. JET ENGINES	MAX SPEED (Mach)	TYPICAL ARMAMENT		
					Guns	Missiles	Rockets
US							
F-4	PHANTOM	1963	2	2.2	1 x 20mm	4	
F-106	DELTA DART	1959	1	2.0	0	4	1
F-102	DELTA DAGGER	1959	1	1.5	0	4	
F-101	VOODOO	1958	2	1.8	0	2	2
USSR							
MIG-17	FRESCO D	1953	1	Subsonic	0	4	
MIG-19	FARMER B/E	1955	2	1.3	3 x 30mm	4	
MIG-23	FLOGGER B	1972	1	2.85	1 x 23mm	6	
MIG-25	FOXBAT A	1971	2	2.83	0	4	
SU-9	FISHPOT B	1959	1	2.1	0	4	
SU-11	FISHPOT C	1967	1	2.1	0	4	
SU-15	FLAGON A/D/E/F	1967	2	2.5	0	4	
TU-128	FIDDLER	1962	2	1.75	0	4	
YAK-28P	FIREBAR	1962	2	1.85	0	2	

APPENDIX B

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